Statement of Qualifications

DR. LEE L. SELWYN

Dr. Lee L. Selwyn has been actively involved in the telecommunications field for more than twenty-five years, and is an internationally recognized authority on telecommunications regulation, economics and public policy. Dr. Selwyn founded the firm of Economics and Technology, Inc. in 1972, and has served as its President since that date. He received his Ph.D. degree from the Alfred P. Sloan School of Management at the Massachusetts Institute of Technology. He also holds a Master of Science degree in Industrial Management from MIT and a Bachelor of Arts degree with honors in Economics from Queens College of the City University of New York.

Dr. Selwyn has testified as an expert on rate design, service cost analysis, form of regulation, and other telecommunications policy issues in telecommunications regulatory proceedings before some forty state commissions, the Federal Communications Commission and the Canadian Radio-television and Telecommunications Commission, among others. He has appeared as a witness on behalf of commercial organizations, non-profit institutions, as well as local, state and federal government authorities responsible for telecommunications regulation and consumer advocacy.

He has served or is now serving as a consultant to numerous state utilities commissions including those in Arizona, Minnesota, Kansas, Kentucky, the District of Columbia, Connecticut, California, Delaware, Maine, Massachusetts, New Hampshire, Vermont, New Mexico, Wisconsin and Washington State, the Office of Telecommunications Policy (Executive Office of the President), the National Telecommunications and Information Administration, the Federal Communications Commission, the Canadian Radio-television and Telecommunications Commission, the United Kingdom Office of Telecommunications, and the Secretaria de Comunicaciones y Transportes of the Republic of Mexico. He has also served as an advisor on telecommunications regulatory matters to the International Communications Association and the Ad Hoc Telecommunications Users Committee, as well as to a number of major corporate telecommunications users, information services providers, paging and cellular carriers, and specialized access services carriers.

Dr. Selwyn has presented testimony as an invited witness before the U.S. House of Representatives Subcommittee on Telecommunications, Consumer Protection and Finance and before the U.S. Senate Judiciary Committee, on subjects dealing with restructuring and deregulation of portions of the telecommunications industry.

In 1970, he was awarded a Post-Doctoral Research Grant in Public Utility Economics under a program sponsored by the American Telephone and Telegraph Company, to conduct research on the economic effects of telephone rate structures upon the computer time sharing industry. This work was conducted at Harvard University's Program on Technology and Society, where he was appointed as a Research Associate. Dr. Selwyn was also a member of the faculty at the College of Business Administration at Boston University from 1968 until 1973, where he taught courses in economics, finance and management information systems.

Dr. Selwyn has published numerous papers and articles in professional and trade journals

on the subject of telecommunications service regulation, cost methodology, rate design and pricing policy. These have included:

"Pricing Telephone Terminal Equipment Under Competition"
Public Utilities Fortnightly
December 8, 1977

"Deregulation, Competition, and Regulatory Responsibility in the Telecommunications Industry"
Presented at the 1979 Rate Symposium on Problems of Regulated Industries - Sponsored by: The American University, Foster Associates, Inc., Missouri Public Service Commission, University of Missouri-Columbia
Kansas City, MO - February 11 - 14, 1979

"Sifting Out the Economic Costs of Terminal Equipment Services"
Telephone Engineer and Management
October 15, 1979

"Usage-Sensitive Pricing" (with G. F. Borton)
(a three part series)
Telephony
January 7, 28, February 11, 1980

"Perspectives on Usage-Sensitive Pricing"
Public Utilities Fortnightly
May 7, 1981

"Diversification, Deregulation, and Increased Uncertainty in the Public Utility Industries"
Comments Presented at the Thirteenth Annual Conference of the Institute of Public Utilities
Williamsburg, VA - December 14 - 16, 1981

"Local Telephone Pricing: Is There a Better Way?; The Costs of LMS Exceed its Benefits: a Report on Recent U.S. Experience."
Proceedings of a conference held at Montreal, Quebec - Sponsored by Canadian Radio-Television and Telecommunications Commission and The Centre for the Study of Regulated Industries, McGill University
May 2 - 4, 1984

"Long-Run Regulation of AT&T: A Key Element of A Competitive Telecommunications Policy"
Telematics
August 1984

"Is Equal Access an Adequate Justification for Removing Restrictions on BOC Diversification?"
Presented at the Institute of Public Utilities Eighteenth Annual Conference
Williamsburg, VA - December 8 - 10, 1986

"Market Power and Competition Under an Equal Access Environment"
Presented at the Sixteenth Annual Conference, "Impact of Deregulation and Market Forces on Public Utilities: The Future Role of Regulation" Institute of Public Utilities, Michigan State University
Williamsburg, VA - December 3 - 5, 1987

"Contestable Markets: Theory vs. Fact"
Presented at the Conference on Current Issues in Telephone Regulations: Dominance and Cost Allocation in Interexchange Markets - Center for Legal and Regulatory Studies Department of Management Science and Information Systems - Graduate School of Business, University of Texas at Austin
October 5, 1987

"The Sources and Exercise of Market Power in the Market for Interexchange Telecommunications Services"
Presented at the Nineteenth Annual Conference - "Alternatives to Traditional Regulation: Options for Reform" - Institute of Public Utilities, Michigan State University
Williamsburg, VA, December, 1987

"Assessing Market Power and Competition in The Telecommunications Industry: Toward an Empirical Foundation for Regulatory Reform"
Federal Communications Law Journal
Vol. 40 Num. 2, April 1988

"A Perspective on Price Caps as a Substitute for Traditional Revenue Requirements Regulation"
Presented at the Twentieth Annual Conference - "New Regulatory Concepts, Issues and Controversies" - Institute of Public Utilities, Michigan State University
Williamsburg, VA, December, 1988

"The Sustainability of Competition in Light of New Technologies" (with D. N. Townsend and P. D. Kravtin)
Presented at the Twentieth Annual Conference - Institute of Public Utilities Michigan State University
Williamsburg, VA, December, 1988

"Adapting Telecom Regulation to Industry Change: Promoting Development Without Compromising Ratepayer Protection" (with S. C. Lundquist)
IEEE Communications Magazine January, 1989

"The Role of Cost Based Pricing of Telecommunications Services in the Age of Technology and Competition"
Presented at National Regulatory Research Institute Conference, Seatle, July 20, 1990.

"A Public Good/Private Good Framework for Identifying POTS Objectives for the Public Switched Network" (with Patricia D. Kravtin and Paul S. Keller)
Columbus, Ohio: *National Regulatory Research Institute*, September 1991.

"Telecommunications Regulation and Infrastructure Development: Alternative Models for the Public/Private Partnership"
Prepared for the Economic Symposium of the International Telecommunications Union Europe Telecom '92 Conference, Budapest, Hungary, October 15, 1992.

"Efficient Infrastructure Development and the Local Telephone Company's Role in Competitive Industry Environment" *Presented at the Twenty-Fourth Annual Conference, Institute of Public Utilities, Graduate School of Business, Michigan State University, "Shifting Boundaries between Regulation and Competition in Telecommunications and Energy", Williamsburg, Virginia,*

"Measurement of Telecommunications Productivity: Methods, Applications and Limitations" (with Françoise M. Clottes)
Presented at Organisation for Economic Cooperation and Development, Working Party on Telecommunication and Information Services Policies, '93 Conference "Defining Performance Indicators for Competitive Telecommunications Markets", Paris, France, February 8-9, 1993.

"Market Failure in "Open" Telecommunications Networks: Defining the New "Natural Monopoly"
Presented at the Tenth Michigan Conference on Public Utility Economics, Western Michigan University, Kalamazoo, Michigan, March 26, 1993. Also forthcoming in *Utilities Policy*, January, 1994.

"Telecommunications Investment and Economic Development: Achieving efficiency and balance among competing public policy and stakeholder interests"
Presented at the 105th Annual Convention and Regulatory Symposium, National Association of Regulatory Utility Commissioners, New York, November 18, 1993.

"The Potential for Competition in the Market for Local Telephone Services"

(with David N. Townsend and Paul S. Keller)
Presented at the Organization for Economic Cooperation and Development ***Conference*, December 6-7, 1993.

"Market Failure in Open Telecommunications Networks: Defining the new natural monopoly," *Utilities Policy*, Vol. 4, No. 1, January 1994.

"The Enduring Local Bottleneck: Monopoly Power and the Local Exchange Carriers," (with Susan M. Gately, et al) a report prepared by ETI and Hatfield Associates, Inc. for AT&T, MCI and CompTel, February 1994.

Dr. Selwyn has been an invited speaker at numerous seminars and conferences on telecommunications regulation and policy, including meetings and workshops sponsored by the National Telecommunications and Information Administration, the National Association of Regulatory Utility Commissioners, the U.S. General Services Administration, the Institute of Public Utilities at Michigan State University, the National Regulatory Research Institute at Ohio State University, the Harvard University Program on Information Resources Policy, the Columbia University Institute for Tele-Information, the International Communications Association, the Tele-Communications Association, the Western Conference of Public Service Commissioners, at the New England, Mid-America, Southern and Western regional PUC/PSC conferences, as well as at numerous conferences and workshops sponsored by individual regulatory agencies.

Appendix 2

APPENDIX F

INPUT PRICES AND TOTAL FACTOR PRODUCTIVITY

by C. Anthony Bush and Mark Uretsky[1]

I. Introduction

In a competitive market, the price of a product is driven to its economic costs by the forces of competition. If input prices of firms decline, price competition among incumbent firms and from new entrants that are enticed into the market by "economic profits"[2] drives the price of the product down to reflect the decline. Thus, under competition, declines in input prices flow through to consumers in the form of lower output prices.

Under the total factor productivity (TFP) framework, advocated by USTA and most exchange carriers, growth in TFP is a measure of the improvement by which factor inputs (labor, land, and capital) are combined within a firm or industry to produce outputs of goods and services. Changes in the cost of inputs are largely outside the firm's control and are excluded from such a measure. However, the TFP studies put on the record in this proceeding (Christensen Studies)[3] do allow measurement of input price changes as a byproduct of the measurement of TFP changes. Thus the results of the TFP studies include a measurement of the change in TFP as well as a separate measurement of the change in input prices.

All parties agree that, in competitive markets, changes in output prices reflect changes in input prices as well as changes in TFP. They also agree that, to replicate the results of a competitive market, a "productivity offset" to inflation (i.e., an X-Factor) must reflect both TFP changes and input price changes.[4] The parties disagree, however, as to the magnitude of the effect of including the input price changes. USTA argues that short-run (i.e., post-divestiture) measurements of input prices are unreliable and that the X-Factor should

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[1] Mr. Bush is Industry Economist and Mr. Uretsky is Chief Economist, Common Carrier Bureau, Federal Communications Commission.

[2] Economic profits are profits that exceed the cost of capital.

[3] USTA Comments, Attachment 6 (Christensen, Schoech, and Meitzen, "Productivity of the Local Telephone Operating Companies"); see also USTA January 12, 1995 Ex Parte (Christensen, Christensen, and Schoech, "Total Factor Productivity in the Bell System", Sept. 1981) and USTA January 20, 1995 Ex Parte.

[4] See USTA Comments, Attachment 5; National Economics Research Associates (NERA), "Economic Performance of the LEC Price Cap Plan" (NERA Study), pp. 8-11; Ad Hoc Reply, Attachment A; David J. Roddy and Lee L. Selwyn of Economics, Technology, Inc. (ETI), "An Empirical Estimate of the LEC Price Cap "X Factor" Based Upon Historic National LEC Productivity and Input Price Trends" (ETI Study), pp. 5-7 and pp. 10-15. AT&T Reply, Appendix C.

incorporate the long-run difference in input prices between the LEC industry and the U.S. economy, which USTA claims is zero.[5] Ad Hoc argues that the X-Factor should incorporate the difference in input prices between the LEC industry and the U.S. economy for the post-divestiture period, i.e., the same time period for which TFP is measured.[6] The effect of including input prices in the X-Factor is potentially large. For example, the inclusion of the effect of input prices under Ad Hoc's proposal would cause the X-Factor for the 1984 - 1992 period to increase from 2.3 percent to 5.2 percent.

In this appendix, we conclude that an X-Factor based on Christensen's LEC TFP data and the Bureau of Labor Statistic's (BLS) U.S. economy TFP data for the period 1984 - 1990[7] should include an adjustment for input prices. We also conclude that such input prices should be derived from Christensen's and BLS's TFP data for the same period (1984 - 1990). In addition, based on the latest data available from Christensen and the BLS, we find that such an X-Factor, excluding the consumer productivity dividend (CPD), would be at least 4.8 percent.

II. Mathematical Background

In order to understand the debate over the proper treatment of input prices under a TFP approach, familiarity with several different formulas for the X-Factor is important. From a mathematical perspective, the various formulas cited by the parties are equivalent. In this section, the formulas are presented and derived. The percentage change in a variable is denoted by a prefix (%); multiplication is denoted by (*).

TFP is defined as the ratio of real (deflated) output to real input. For a simple model of one output and one input, we have:

$$TFP = Q / I, \qquad \text{(Equation 1)}$$

where
Q = output, and
I = input

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[5] NERA Study, p. 16; NERA Reply, p. 6.

[6] ETI Study, pp. 10 -17.

[7] Although the petitioners' arguments pertain to the post-divestiture period 1984 - 1992, we reach a finding in this Appendix specifically with respect to the period 1984 - 1990, because this is the period that is relevant for purposes of corroborating the findings of the recalculated "Frentrup-Uretsky" study that the X-Factor during the period 1984 - 1990 was 5.0 percent. See Appendix D.

We can show that growth in TFP equals growth in output less growth in input:[8]

$$\%TFP = \%Q - \%I, \qquad \text{(Equation 2)}$$

where
%TFP is percentage change in productivity,
%Q is percentage change in output, and
%I is percentage change in input

Assuming competition, it can be shown that, in general, the growth in TFP equals the growth in input prices less the growth in output prices:[9]

$$\%TFP = \%W - \%P \qquad \text{(Equation 3)}$$

where
%P is percentage change in price of each unit of output Q, and
%W is percentage change in price of each unit of input I

Given these equations, we can derive a formula for LEC price changes under perfect competition:[10]

$$\%P^{LEC} = \%P^{US} - [(\%TFP^{LEC} - \%TFP^{US}) - (\%W^{LEC} - \%W^{US})]$$

(Equation 4)

where
$\%P^{LEC}$ is percentage change in LEC output prices,
$\%P^{US}$ is percentage change in U.S. output prices (i.e., inflation),
$\%TFP^{LEC}$ is percentage change in TFP for the LEC industry,
$\%TFP^{US}$ is percentage change in the TFP for the U.S. economy,

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[8] Taking logarithms of equation (1) and differentiating with respect to time, noting that the time derivative of the logarithm of a variable is approximately equal to the percentage change of that variable, yields equation (2).

[9] In competitive equilibrium revenue equals cost:

$$P * Q = W * I.$$

Thus,

$$Q / I = W / P$$

and

$$TFP = W / P$$

Taking logarithms and differentiating with respect to time, noting that the time derivative of the logarithm of a variable is approximately equal to the percentage change of that variable, yields equation (3).

[10] Subtracting equation (3) for TFP^{US} from equation (3) for TFP^{LEC} and rearranging terms results in equation (4).

$\%W^{LEC}$ is percentage change in the input prices for the LEC industry,

and

$\%W^{US}$ is percentage change in the input prices for the U.S. economy

The term in brackets in equation (4) is the theoretical equivalent of the X-Factor (excluding the CPD), under the TFP framework. In other words, the X-Factor is the offset to inflation ($\%P^{US}$) which forces LEC price changes ($\%P^{LEC}$) to behave as would be required in a competitive market. Thus we have

$$X = (\%TFP^{LEC} - \%TFP^{US}) + (\%W^{US} - \%W^{LEC}),$$

(Equation 5)

The X-Factor depends on TFP differences between the LEC industry and the US economy ("TFP differential") and on input price differences between the LEC industry and the US economy ("input price differential").

It also can be shown that there is another, equivalent, formula for the X-Factor that replaces measures of TFP change and input price change for the US economy with a measure of output price change for the US economy:[12]

$$X = \%TFP^{LEC} + \%P^{US} - \%W^{LEC},$$ (Equation 6)

Furthermore, we can rewrite equation (3), as applied to LECs, as

$$\%P^{LEC} = \%W^{LEC} - \%TFP^{LEC}.$$ (Equation 7)

This means that using this approach is equivalent to just basing LEC output prices on LEC input prices and LEC productivity, without the need for any US aggregate data for prices or productivity.

III. Comments and Ex Partes

Introduction. The parties disagree on whether the input price differential for the 1984-1992 time period is an accurate or meaningful measurement. Both Christensen Associates (Christensen) and National Economics Research Associates (NERA), economic consultants to USTA, argue that short-run input price data exhibit substantial volatility and cannot be relied upon as accurate.[13] Christensen argues that the LEC input price series from

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[11] To construct US input price growth, private business sector TFP growth is added to GDP-PI growth. See USTA January 13, 1995 Ex Parte.

[12] Equation (6) can be derived by substituting the formula for $\%TFP^{US}$ from equation (3) into equation (5).

[13] See NERA Study; see also USTA February 1, 1995 Ex Parte, p. 9-10; NERA Reply, p. 31.

his TFP studies are not directly comparable to the U.S. input price series for the 1984 - 1992 time period and that, if a comparison is made, there will be substantial volatility in the input price differential. Christensen argues that the short-run differential between LEC and U.S. input prices should be ignored in favor of his finding that the long-run differential between LEC and U.S. input prices is zero.[14] NERA concurs with Christensen and outlines additional volatility problems with Christensen's LEC input price data for the 1984-1992 time period.[15]

Ad Hoc argues that LEC input price data for the 1984-1992 period are derived directly from Christensen's TFP studies and are as reliable as Christensen's TFP study. Further, Ad Hoc argues that these data show an important change in the long-run trend of LEC input prices and thus must be the basis for any input price component included in the X-Factor for the post-divestiture period.[16]

USTA According to USTA's economic consultants, only long-run measures of LEC input prices are reliable enough for inclusion in the X-Factor. They claim that because the long-run input price differential is zero, the input price differential in equation (5) should be zero and the X-Factor should simply reflect the TFP differential. USTA's economic consultants believe that the proper measurement of the X-Factor over the period 1984-1992 is 1.7 percent,[17] i.e., the difference between price cap LEC TFP growth and U.S. TFP growth for that period. Their reasoning, presented in various studies and ex parte filings, can be summarized as follows: (1) the input price differential can be estimated reliably only for the long-run; (2) the long-run measure of the input price differential is zero percent; and (3) therefore, the X-Factor should include only the TFP differential.

The Long-Run. USTA's economic consultants make several arguments in support of the view that the long-run input price differential is zero percent. In the USTA February 1, 1995 Ex Parte, Christensen argues:

> Telephone companies compete for labor, capital, and other inputs with all other sectors of the U.S. economy. Thus, one would expect input prices for telephone companies to have the same long-term trend as other sectors of the economy, and hence, the same as the entire U.S. economy. This expectation is validated by long-term historical

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[14] USTA February 1, 1995 Ex Parte, p. 9

[15] NERA Reply, pp. 28-32.

[16] Ad Hoc Reply, pp. 10-13; Ad Hoc Ex Parte, pp. 6-8. Ad Hoc, however, finds fault with downward revisions that Christensen made to the LEC input price series as reflected in the USTA February 1, 1995 Ex Parte. See also footnote 31, below.

[17] Subsequent changes in BLS's measurement of U.S. TFP and the corrections of errors in the Christensen TFP study result in a revised measure of the TFP differential of 2.1 percent. See USTA January 20, 1995 Ex Parte, p.16.

experience.[18]

USTA's economic consultants present various time-series (i.e., annual data for a sequence of years) to show that the input price differential is negligible and not statistically different than zero. NERA compares a time-series of telephone industry input price growth rates derived from various Christensen TFP studies and a time-series of U.S. economy input price growth rates that NERA constructs from BLS's TFP studies for the U.S. economy and measures of inflation.[19] The comparison is for the time period 1959 - 1992 and shows that the input price differential averages about 0.7 percent.[20] NERA claims that the input price differential of 0.7 percent is statistically indistinguishable from zero percent. Based on econometric techniques, NERA constructs a "95 percent confidence interval" using 0.7 percent. A "95 percent confidence interval" is an interval which captures the true mean of the input price differential with a probability of 95 percent. In NERA's study, the 95 percent confidence interval has an upper bound of 2.1 percent and a lower bound of -0.6 percent. NERA claims that because zero percent is within the 95 percent confidence interval, it is statistically indistinguishable from 0.7 percent.

Christensen presents a time-series of telephone industry and U.S. economy input price growth rates from 1949 to 1992 to show that the input price differential averages only 0.1 percent. Christensen conducts statistical tests of the hypothesis that the trend in input price growth for the telephone industry equals the trend in input price growth for the U.S. economy. In the Christensen Affidavit, Christensen concludes that there is no evidence that the input price trends differ.[21]

The Short-Run. USTA's economic consultants also present evidence regarding the short-run input price differential. Christensen tested whether the average input price differential was equal to zero for the period 1983-1992 and found that the difference is not statistically significant. According to Christensen, the average input price differential was 2.6 percent.[22] Christensen claims that this differential is statistically indistinguishable from zero percent, presumably because 2.6 percent falls within a 95 percent confidence interval, which

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[18] USTA February 1, 1995 Ex Parte, p. 5.

[19] NERA's time-series of U.S. economy input price growth rates is based on equation (3), above.

[20] USTA January 13, 1995 Ex Parte. Note that NERA computes the input price differential as $\%W^{US} - \%W^{LEC}$ so that positive 0.7 indicates that the change in LEC input prices is 0.7 percentage points less than the change in U.S. input prices.

[21] USTA February 1, 1995 Ex Parte, p. 5 (Christensen Affidavit).

[22] Christensen Affidavit and USTA February 22, 1995 Ex Parte.

also contains zero.[23]

Both NERA and Christensen claim that, in the short-run, LEC input price data contained in the Christensen Studies cannot be reliably compared to U.S. input price data. They contend that such a comparison will yield volatile results that can only be corrected by averaging prices over the long-run. Christensen argues that:

> There is no reason to expect telephone company input prices to rise slower than input price growth for other sectors of the U.S. economy. This concept is validated by the fact that the long-term trends are the same. Short-term input price data exhibit substantial volatility, but provide no evidence of divergent trends.[24]

NERA and Christensen offer various reasons for the volatility, all of which relate to the treatment of capital costs in Christensen's TFP studies.

Christensen asserts that his estimates of capital input prices for the LECs are based on a different method than the estimates of capital input prices for the U.S. economy derived from the BLS's TFP studies and that a comparison between them is invalid.[25] According to Christensen, because the BLS's measurement of U.S. TFP reflects economic profits as well as the opportunity cost of capital (interest rates), economic profits are included in the input price series for the U.S. economy. Christensen states that his measurements of LEC input prices exclude economic profits and are, therefore, not comparable to the U.S. input price series. According to Christensen, an input price differential based on subtracting one series from the other is invalid. Because the input price differential for the post-divestiture period reflects such a comparison, Christensen claims that it is invalid.

NERA points out that the input price indexes for the telephone industry are byproducts of Christensen's TFP studies and, because of the methods used in the studies to measure capital prices, are more volatile than ordinary input price indexes.[26] NERA argues that, although the accuracy of the measurement of capital prices is adequate for calculating changes in the LECs' TFP, it is not adequate for calculating changes in the LECs' input prices.[27] Such measurements, NERA asserts, are unrealistically volatile. Thus, NERA claims, short-run measurements of the input price differential are unreliable.

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[23] NERA also undertook a short-term study of post-divestiture data, but did not provide any supporting statistics.

[24] USTA February 1, 1995 Ex Parte, p. 9.

[25] USTA February 1, 1995 Ex Parte, pp. 8-9.

[26] NERA Reply, pp. 28-31.

[27] NERA Reply, pp. 28-31.

Ad Hoc In its reply, Ad Hoc submits a study by Economics, Technology, Inc. (ETI)[28] which argues that Christensen's and NERA's claim that the input price differential is zero and should be excluded from the calculation of the X-Factor is incorrect.[29] ETI maintains that the data derived from the Christensen Studies[30] show that the annual growth rate of LEC input prices was 1.1 percent[31] during the 1984 - 1992 period. ETI also points out that this growth rate is significantly different from 4.6 percent,[32] which ETI estimates was the growth rate of U.S. input prices during the same period.[33] Ad Hoc uses equation (6) to derive an X-Factor of 5.2 percent for the period 1984 - 1992.[34]

ETI claims that its figure for LEC input price growth for the 1984 - 1992 period should be considered as reliable as the Christensen TFP study because the figure is taken directly from that study. ETI also states that, like Christensen's measurement of TFP growth, it is a simple average for the 1984 - 1992 period and is based on data for a complete aggregation of large price cap companies, rather than a statistical sample.

Ad Hoc presents a theory regarding why input prices for the telephone industry are growing at a slower rate than input prices for the general economy during the post-divestiture period. Ad Hoc claims that slower growth is due, in part, to the substantial productivity and technological gains being experienced in those segments of the telecommunications industry that supply equipment and other capital resources to the LECs.[35] Ad Hoc contends that the telecommunications equipment market has become highly competitive in the decades since the

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[28] ETI Study, pp. 5-7 and pp. 10-15.

[29] ETI Study, p. 12.

[30] Such data includes LEC input prices for the 1984 - 1992 period as contained in USTA's Response of the United States Telephone Association to Ad Hoc's Motion to Compel and Motion for Extension of Time, June 2, 1994 (Christensen Supplemental Data).

[31] ETI Study, p. 13.

[32] ETI Study, p. 13.

[33] ETI relies on equation (3), above, and economic data from BLS to calculate U.S. input price growth of 4.6 percent as the sum of inflation (3.7 percent) and U.S. TFP growth (0.9 percent). Subsequently, BLS revised its estimate of US private business sector TFP growth from 0.9 percent to 0.3 percent, thereby raising Christensen's estimate of the TFP difference from 1.7 percent to 2.3 percent. This revision causes an offsetting change to Ad Hoc's calculation of the U.S. input price growth which declines from 4.6 percent to 4.0 percent. Subsequently, Christensen revised his measurement of the average annual change in LEC input prices for 1984-1992 from 1.1 percent to 1.7 percent. USTA January 20, 1995 Ex Parte. Ad Hoc challenged the validity of the change. Ad Hoc February 3, 1995 Ex Parte.

[34] ETI Study, p. 13. X (excluding CPD) = 2.6 percent (LEC TFP growth) + 3.7 percent (inflation) - 1.1 percent (LEC input price growth) = 5.2 percent.

[35] Ad Hoc February 2, 1995 Ex Parte, p. 6.

break-up of the former Bell System, when the Modified Final Judgment's (MFJ) "manufacturing restriction" was imposed. According to Ad Hoc, under the terms of the MFJ, Bell Operating Companies can no longer purchase equipment and supplies from captive affiliates, but, instead, must acquire such inputs on the competitive market.

Ad Hoc argues that, under competition, a firm's output prices must reflect both productivity changes and input price changes. A reduction of input prices reduces the cost of producing outputs. As firms compete, output prices are driven down to their cost. Ad Hoc concludes that "if LECs were to behave competitively, they would flow through declines in real (i.e., inflation-adjusted) input prices."[36] Ad Hoc concludes that under competition, "an input price decrease will be flowed through to consumers even if no productivity gain were to occur."[37]

AT&T Like Ad Hoc, AT&T opposes USTA's elimination of the input price differential in the estimate of the X-Factor. AT&T asserts that if TFP were to be used, the TFP differential must be adjusted for the difference between the change in GNP-PI and actual input price growth.[38] AT&T would use equation (5), above, to calculate the X-Factor (excluding the CPD) for the period 1984 - 1992 as 5.2 percent.[39]

According to AT&T, the LECs' earnings in the first price cap period exceeded the cost of capital. AT&T questions the theoretical validity of equation (3), given that equation (3) is true only for markets in which output prices are set at levels that allow firms to earn no more than the cost of capital. AT&T states that the theoretical link between Christensen's measurement of TFP growth derived from output and input quantity indices and equation (3) is invalid.[40] AT&T implies that the derivation of the X factor using equation (5) is invalid.

V. Discussion

Introduction. We agree with Ad Hoc's characterization of economic competition. In competitive market equilibrium, firms earn zero economic profits and revenues are equal to economic cost. If input prices for firms in the market decline, competition between existing firms and entry by new firms, which are attracted by economic profits, forces the output price down to cost, which now reflects the lower input prices. This implies that a reduction of input

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[36] Ad Hoc reply Comments, Attachment A, p. 11.

[37] Ad Hoc Reply, Attachment A, p. 16.

[38] AT&T Reply, pp. 28-29.

[39] X = 1.7 percent (the TFP differential) + 3.5 percent (the input price differential) = 5.2 percent. The TFP differential = 2.6 percent (LEC TFP growth) - 0.9 (U.S. TFP growth) = 1.7 percent. The input price differential = 4.6 percent (U.S. input price growth) - 1.1 percent (LEC input price growth) = 3.5 percent.

[40] AT&T Reply, Appendix C, pp. 8-9.

of input prices will be flowed through to consumers in the form of reduced output prices.

The price cap equations, described above, show that the only mechanism that flows changes in LEC input prices through to changes in LEC output prices is the input price differential. Thus, as a theoretical matter, we believe that inclusion of the input price differential, as specified in equation (5), for instance, is essential to the proper calculation of the X-Factor.

We believe that AT&T's contention that equation (5) erroneously omits a correction for LEC profit growth is unfounded. AT&T appears to be concerned that either the growth rate in LEC TFP or the growth rate in LEC input prices will be calculated using equation (3). However, under Christensen's framework, the growth rates for both LEC TFP and LEC input prices are not determined by reliance on equation (3). The X-Factor will not be biased by the LECs' economic profits. Used as a "productivity offset" as in equation (4), the X-Factor will result in output prices that mimic perfect competition.

The issue before us is to make a reasonable determination of the input price differential for the post-divestiture period and, in particular, the period 1984-1990. Specifically, we need to consider whether USTA is correct in its assertion that short-run measures of the input price differential are inaccurate and should be supplanted by a long-run estimate for use in calculating the X-Factor. We also need to consider whether the long-run estimate of the input price differential is indeed zero, as USTA claims.

We begin with an evaluation of the evidence regarding the input price differential for the post-divestiture period. Data on the TFP differential and the input price differential for the post-divestiture period has been placed in the record by USTA in the Christensen Supplemental Data, USTA January 13, 1995 Ex Parte, USTA January 20, 1995 Ex Parte, and the Christensen Affidavit. In the January 20, 1995 Ex Parte and the Christensen Affidavit, USTA filed its latest view of post-divestiture TFP and input price data. These data contain significant revisions to the earlier filings. These revisions apparently reflect corrections, contained in the January 20, 1995 USTA Ex Parte, to the Christensen TFP study which was filed as part of USTA's original comments. The LEC TFP growth and LEC input price growth for the post-divestiture period are significantly reduced from data contained in the earlier study. These data show that, for the eight year post-divestiture period (1984 - 1992), LEC input prices grew at an average annual rate of 1.7 percent, while U.S. economy input prices grew at an average annual rate of 4.0 percent, resulting in an input price differential of 2.2 percent (rounded). The TFP differential was 2.1 percent, resulting in an X-Factor of 4.3 percent, using equation (5). Making the same calculations for the 1984-1990 time period, we have an X-Factor of 4.8 percent, equal to the sum of the input price differential (2.7 percent) and TFP differential (2.1 percent). See Attachment A.[41]

[41] Attachment A contains time-series data of annual percentage changes in input prices as well as other data. The entries are in sequence by year. Each year's entry represents the annual percentage growth in input prices over the prior year. For instance, the 1985 growth rate reflects growth from 1984 to 1985. Thus, growth from

In deciding whether to rely on the post-divestiture period for the purpose of calculating the input price differential, we are persuaded by Ad Hoc that significant weight should be placed on the fact that the LEC input price data for that period come directly from Christensen's own TFP study. However, USTA's economic consultants have raised several important criticisms regarding reliance on post-divestiture data which we need to consider before reaching a decision.

Measurement Errors in the Post-Divestiture Input Price Data. As described above, Christensen argues that measures of the post-divestiture input price differential which are based on a comparison between input price data derived from BLS studies and input price data derived from Christensen's own studies are invalid, because of differences in method.[42] We have reviewed BLS's technical literature on multifactor productivity and have verified that Christensen is correct that profits are included in BLS's measurement of capital costs. This implies that measurements of growth rates of U.S. TFP have profit embedded in them as do, in consequence, measurements of growth rates of U.S. input prices which are derived from growth rates in U.S. TFP.[43] However, we believe that an opposite bias of equal magnitude is contained in the TFP differential that USTA would use to set the X-Factor. See Attachment B. We conclude that the sum of the TFP differential and the input price differential will be unbiased and that the X-Factor, which equals the sum, will be unbiased.[44]

As described above, NERA argues that measurement problems related to capital prices cause volatility in the input price differential and make short-run measurements of the input price differential unreliable. NERA has not demonstrated, however, that these measurement problems introduce a bias into the input price series. Also, although NERA has shown that the measurement problems could cause considerable year to year fluctuations, NERA has not shown that such fluctuations could make a six year period (e.g., for 1984 - 1990) unreliable. Based on the record before us, we have no reason to conclude that the measurement problem that NERA describes affects the calculation of input price differential for the 1984 - 1990 period.

In summary, USTA's economic consultants' descriptions of problems in measuring changes in post-divestiture input prices fails to convince us that the problems are serious enough to warrant rejection of the measurements for use in calculating an X-Factor.

Short-Run Versus Long-Run Measurement of the Input Price Differential. We next consider whether we should rely on short-run or long-run input price data to forecast the

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in the average growth rate from 1986 - 1990.

[42] Christensen Affidavit, pp. 8-9.

[43] See equation (3), above.

[44] See equation (5).

future trend in input prices. In particular, we evaluate USTA's view that the post-divestiture input price differential is an aberration from an underlying long-run trend in which the differential is zero. To support this view, both Christensen and NERA have provided studies of input price time-series data, including statistical tests. For instance, the Christensen Affidavit contains input price data for the telephone industry and the U.S. economy from 1949 to 1992. Using this data, Christensen has performed statistical tests to see whether the hypothesis that the input price differential is zero over the long-run is refutable. Based on his calculations, he concludes that the hypothesis is valid. He also concludes that the deviation of the post-divestiture input price differential from the long-run trend is not significant in a statistical sense.

We disagree with this viewpoint for several reasons. First, Christensen has not supported his view that, because telephone companies compete for labor, capital, and other inputs with all other sectors of the economy, input prices for telephone companies should have the same long-run trend as the entire U.S. economy.[45] Assuming different rates of technological change among various sectors of the economy, the price of inputs to a particular sector simply may be changing more rapidly than that of the U.S. economy as a whole. This might be true especially for the telephone industry, in which the cost of many inputs, e.g., computers, switches, and fiber optic technology, appear to be growing less rapidly than cost of inputs for the U.S. economy as a whole. Christensen has not offered adequate theoretical support for his premise that telephone industry input prices should grow at the same rate as input prices in the economy generally.

Second, the various data series placed on the record by USTA are not all in accord that the long-run input price differential is, in fact, zero. In NERA's series from 1960 - 1992, the input price differential is 0.7 percent.[46] Although NERA claims that the 0.7 percent difference over the 32 year period is not significantly different from zero, NERA's statistical test is not convincing. NERA's finding that a mean of 0.7 percent is not statistically different than a mean of zero is based on a 95 percent confidence interval standard. We believe that such a test is too stringent when used to support a hypothesis with little theoretical support. The test shows that if zero were the true mean during this period, a sample mean greater or equal to 0.7 percent would occur less than approximately 15 percent of the time.[47] Based on NERA's evidence, we conclude it is more likely than not that a number greater than zero percent is the long-run input price differential.

Christensen presents a time-series of telephone industry and U.S. economy input price growth rates from 1949 to 1992 to show that the input price differential averages only 0.1

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[45] USTA February 1 Ex Parte, p. 5. See full quote in comment section, above.

[46] See comment section, above.

[47] In other words, a confidence interval of about 70 percent around the sample mean would not contain zero.

percent.[48] Although these numbers appear more consistent with a hypothesis of a zero percent long-run price differential, Christensen's time-series is completely different from NERA's, although both are based on data from various studies by Christensen.[49] Christensen has provided no justification for using a different version of the LEC input price series for the period 1960-1984 than NERA's version. Further, Christensen provides no justification for using a different beginning date for the series than NERA (1949 instead of 1960). Because of these discrepancies, we cannot accept Christensen's conclusion that the input price differential is zero.

Third, there is evidence that the input price differential for the post-divestiture period is not part of a zero long-run trend. Christensen attempts to show that the input price differential for the post-divestiture period (at least 2.6 percent) is not statistically different than zero. We do not find Christensen's showing to be convincing, for the same reasons we found unconvincing NERA's showing that 0.7 was not statistically different from zero. His finding that a mean of 2.6 percent is not statistically different than a mean of zero is based, again, on a 95 percent confidence interval standard. We believe that such a test is too stringent when used to support a hypothesis with little theoretical support. Looked at another way, the test shows that if zero were the true mean during this period, a sample mean greater or equal to 2.6 percent would occur less than approximately 7.5 percent of the time.[50] Based on this finding, we conclude there is evidence that the post-divestiture input price differential is not consistent with a long-run trend of zero percent.

We tested Ad Hoc's hypothesis that divestiture explains why LEC input prices appear to be growing at a substantially slower rate than economy-wide input prices during the 1984-1992 period. See Attachment C. We performed several statistical tests, all of which confirmed the plausibility of Ad Hoc's hypothesis. We regressed NERA's time series of telephone industry input prices for the period 1959-1992 (as updated for period 1984 - 1992 in the Christensen Affidavit) against NERA's time series of U.S. input prices, interest rates, and a binary variable for divestiture. We performed the same test for Christensen's time series of telephone company and U.S. input price data for the period 1948-1992. In both cases, we found divestiture to a significant factor. We also regressed the input price differential against interest rates and a binary variable for divestiture, for NERA's and Christensen's data, respectively. Our findings were the same as for the first two tests - divestiture appears to be a significant factor. Although more research needs to be done before we conclude that divestiture is a major factor in slowing the rate of growth of telephone company input prices, these tests provide evidence that the post-divestiture period represents a

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[48] USTA Ex Parte, February 1, 1995, p. 5. See comment section, above.

[49] For instance, Christensen's growth rates for telephone industry input prices are 4.2 percent for 1960, 3.9 percent for 1961, and 2.2 percent for 1962, compared to NERA's growth rates of 2.4 percent, 4.0 percent, and 3.1 percent, respectively. There are also serious discrepancies in the time series for U.S. input prices.

[50] In other words, a confidence interval of about 85 percent around the sample mean would not contain zero.

significant break from the past.

Based on these considerations, we believe that an input price differential based on long-run, pre-divestiture data is not a reasonable basis on which to calculate the input price differential for the post-divestiture period. We believe that the input price differential for the post-divestiture period should be calculated using post-divestiture data. In particular, we believe that the input price differential for the 1984-1990 period should be based on data from that period.

For purposes of calculating the historical X-Factor for the period 1984-1990 under a TFP framework, we conclude that the input price differential for the 1984-1990 period should be used. We also conclude that the input price differential for this period should be measured as the difference between the average 1984-1990 LEC input price change, derived from the Christensen study, and the average 1984-1990 U.S. input price change, derived from BLS TFP data. Relying on Christensen's and BLS's latest data, the X-Factor (excluding the CPD) for the 1984-1990 period is 4.8 percent.

Revised TFP and Input Price Study

A Year	B US Input Price Growth	C Telecom* Input Price Change	D Difference US Input – Telecom Input	E Telecom TFP Growth	F US TFP Growth	G Difference Telecom TFP* – US TFP	H X Factor
[illegible]	1.70%	[illegible]	-0.70%	[illegible]	0.40%	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	-1.10%	[illegible]	2.10%	0.10%	-1.00%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.70%	[illegible]	0.70%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.10%	[illegible]	2.00%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.70%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.10%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.40%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.10%
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.10%	n/a	[illegible]	n/a	n/a
[illegible]	[illegible]	[illegible]	[illegible]	n/a	[illegible]	n/a	n/a
[illegible]	[illegible]	[illegible]	[illegible]	n/a	[illegible]	n/a	n/a
[illegible]	[illegible]	[illegible]	[illegible]	n/a	[illegible]	n/a	n/a
[illegible]	[illegible]	[illegible]	[illegible]	n/a	[illegible]	n/a	n/a
[illegible]	[illegible]	[illegible]	[illegible]	1.10%	[illegible]	[illegible]	4.47%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.29%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.10%	[illegible]	3.19%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.31%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.18%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-1.10%	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	n/a	[illegible]	n/a	[illegible]	n/a	n/a	n/a

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.7%	[illegible]	2.3%
[illegible]	[illegible]	[illegible]	[illegible]	n/a	1.1%	n/a	2.4%
[illegible]	n/a	[illegible]	n/a	n/a	n/a	n/a	n/a
[illegible]	[illegible]	[illegible]	1.1%	3.1%	1.4%	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.1%	3.1%	[illegible]	[illegible]	2.9%
[illegible]	[illegible]	[illegible]	2.7%	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.1%	[illegible]	4.7%
[illegible]	[illegible]	1.7%	2.3%	[illegible]	0.3%	2.1%	4.4%
[illegible]	[illegible]	[illegible]	[illegible]	2.7%	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0%	[illegible]	4.7%
[illegible]	[illegible]	[illegible]	2.0%	[illegible]	0.3%	[illegible]	4.3%
[illegible]	[illegible]	[illegible]	n/a	[illegible]	n/a	n/a	n/a
[illegible]	[illegible]	[illegible]	2.4%	[illegible]	0.0%	[illegible]	5.0%
87–91 [illegible]	[illegible]	[illegible]	2.2%	2.3%	[illegible]	[illegible]	[illegible]
91–[illegible] Average	[illegible]	[illegible]	1.1%	2.4%	0.4%	2.0%	3.1%
91–[illegible] Average	n/a	[illegible]	n/a	2.4%	n/a	n/a	n/a

Notes:

Col. B: Input Price Data from [illegible] to 1984 from USTA Ex Parte, Jan 13, Table 2.
Input Price Data from 1985 to 1993 from USTA Ex Parte, Jan 13, Table 1.
Col C: Input Price Data from [illegible] to 1984 from USTA Ex Parte, Jan 13, Table 2.
Input Price Data from 1985 to 1993 from USTA Ex Parte, Jan 20, on disk only – PROD.WK3
1985–1993 data revised from USTA Ex Parte, Jan 13, Table 1.
Col. E: Bell System TFP Data from [illegible] to 1979 from USTA Ex Parte, Jan 12, Table 19.
Data is available back to 1947.
RBOC and GTE TFP Data from 1985 to 1993 from USTA Ex Parte, Jan 20, Table 1.
Col. F: US TFP Data from [illegible] to 1984 from USTA Ex Parte, Jan 13, Table 2.
US TFP Data from 1985 to 1993 from USTA Ex Parte, Jan 13, Table 1.

Profit Bias in the Input Price Differential

For the period 1984-1992 (USTA February 1, 1995 Ex Parte), Christensen calculates the U.S. input price growth as

$$\%W^{US} = GDPPI - \%TFP^{US} \qquad \text{(Equation 1)}$$

NERA (in USTA's January 13, 1995 Ex Parte) employed equation (1) to construct U.S. input price growth for the period 1960-1984, however GNP-PI was used instead of GDP-PI. Given that GDP-PI is the rate of growth of an output price index, the measurement problems associated with profits enters U.S. input price growth through U.S. TFP growth.

However, USTA's measurement of X^{USTA} as the differential rate of growth of TFP,

$$\%TFP^{LEC} - \%TFP^{US},$$

contains the same distortion as the input price differential since it also relies on

$$\%TFP^{US}$$

computed by BLS. Further, as we show below the two distortions cancel out. Let a superscript of * denote the absences of profits in US calculations. Note, all LEC measurements do not include profits. Letting Δ be the term reflecting the effects of profits, then

$$\%W^{US} = \%W^{*US} + \Delta = GDPPI - \%TFP^{*US} + \Delta, \qquad \text{(Equation 2)}$$

where

$$\%TFP^{US} = \%TFP^{*US} + \Delta$$

For the LECs we have

$$\%W^{LEC} = \%P^{LEC} - \%TFP^{LEC} \qquad \text{(Equation 3)}$$

Subtracting equation (3) from equation (2), we have

$$\%W^{US} - \%W^{LEC} = GDPPI + \%TFP^{US} - (\%P^{LEC} + \%TFP^{LEC}) \qquad \text{(Equation 4)}$$

This implies

$$\%P^{LEC} = GDPPI - (\%W^{US} - \%W^{LEC}) - (\%TFP^{LEC} - \%TFP^{US}) \qquad \text{(Equation 5)}$$

Equivalently,

$$\%P^{LEC} = GDPPI - (\%W^{*US} + \Delta - \%W^{LEC}) - (\%TFP^{LEC} - \%TFP^{*US} - \Delta) \qquad \text{(Equation 6)}$$

Thus, the Δ cancels out. This implies that

$$\%P^{LEC} = GNPPI - (\%W^{*US} - \%W^{LEC}) - (\%TFP^{LEC} - \%TFP^{*US}) \qquad \text{(Equation 7)}$$

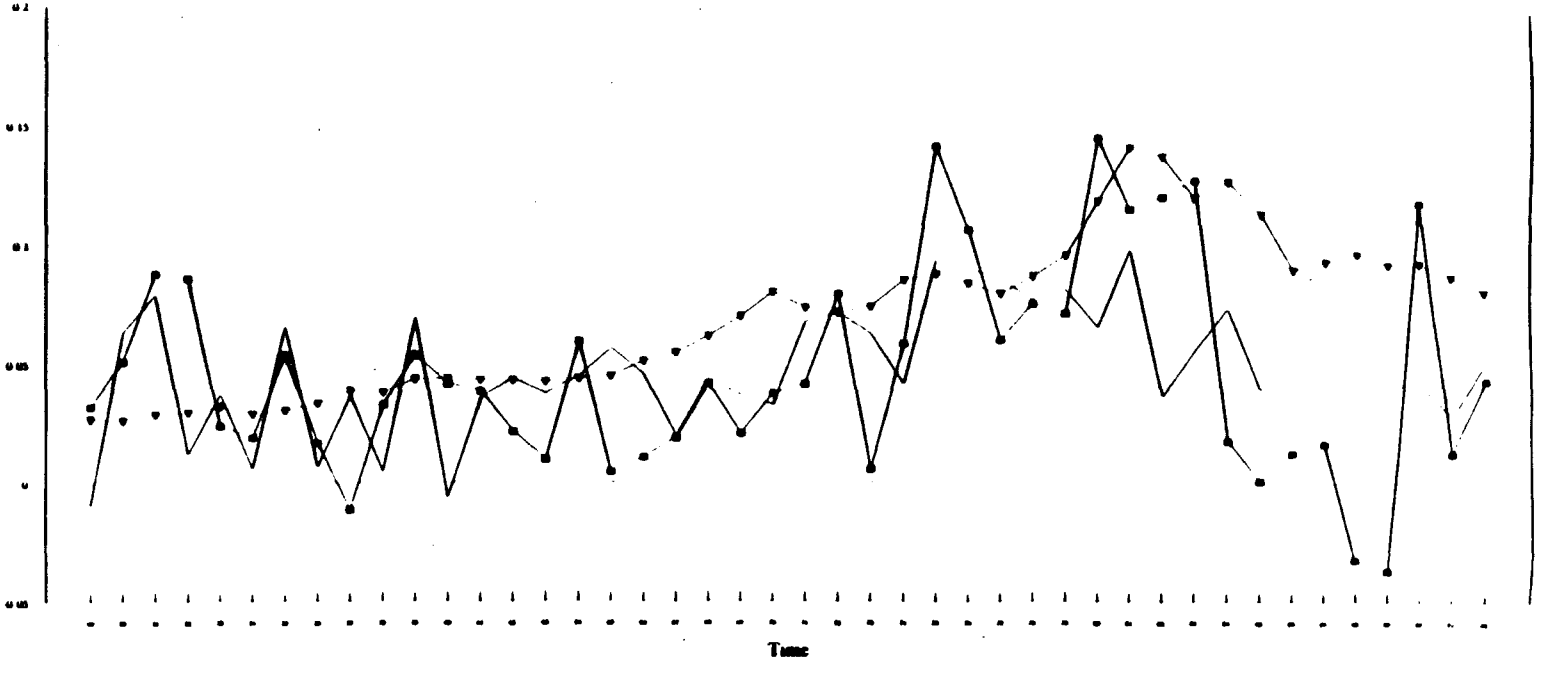
which gives us a correct measurement of X, where

$$X = (\%W^{*US} - \%W^{LEC}) + (\%TFP^{LEC} - \%TFP^{*US}) \qquad \text{(Equation 8)}$$

Therefore, we conclude that the input price differential is, in fact, an essential component of the X factor to correct the distortion in USTA's own measurement of TFP differential.

Attachment C

Telephone Input Price Growth



Telephone Input Price Growth

US Input Price Growth

Moody's Yield on PU Bonds

Source: USTA Ex Post February 1, 1995, Christensen Affidavit

Moody's Yield on Public Utility Bonds, Economic Report of the President, 1994