widely accepted geometric decay model applied and elaborated by Jorgenson and others.

(4) BLS and the PBM use estimated marginal tax rates in the rental price formulas, whereas Christensen appears to use average tax rates.

(5) While it has not yet been adopted throughout its industry productivity measurement program, BLS has acknowledged the superior properties of the Fisher Index as asserted by Diewert (1993). The Productivity Research Division at BLS now uses the Fisher Index in major sector (i.e. total private business sector, private nonfarm business sector) calculations. As noted in AT&T's Comments in Appendix A, an attractive property of the Fisher Ideal Index is that it incorporate directly new outputs and inputs, which is important for measurement in the rapidly evolving telecommunications industry.

4. Moving Average of TFP and the X-Factor

Regarding the three-year moving average, as is noted in the Harper, Berndt and Wood study cited by Christensen, there are other ways in which volatility can br reduced than by the procedure proposed by USTA. It is relevant to note, however, that the addition of BLS data for 1994 on private nonfarm business TFP and input prices changed the X-Factor computed by the PBM by only .02 percent from the computation based on projecting those values to 1994 by their 1985-1993 rates of change. Thus the lag in publication of BLS statistics for the target sector, cited by USTA in its argument for a moving average seems to have no practical

effect. When a final TFP measurement method is finally determined, the moving average issue can be examined in a more focused and definitive way than at present.

E. Updated Results of Performance-Based Model

As previously noted, the Performance-Based Model has been updated to reflect the recently released BLS data on U.S. economy (nonfarm business sector) input prices and TFP applicable to 1994 (along with minor prior year revisions). This model has also been revised to use a measure of capital input derived by the perpetual inventory method. As noted, the capital revision has no effect on the X-Factor. The BLS data became available for private nonfarm business TFP and input price growth in mid-January 1996. Their incorporation raises the X-Factor from 7.33 percent to 7.35 percent. The new results are shown in Table 8. The same data adjusted for separations, as described in Appendix A (pp. 29-30) to the AT&T initial Comments, are shown in Table 8A. As before, the effect of this separations adjustment is to increase the interstate X-Factor by 0.91 percent. Also as before the effects of this separation adjustment are reported to illustrate the conservative nature of the results in the Performance-Based Model, as shown in Table 8.

Table 8. TFP, Input Price Differential and X-Factor in Interstate and All LEC Regulated Services: Rates of Growth, 1985-1994

	Interstate Access Services	All LEC Regulated Services
Output Growth	6.83%	4.90%
-Input Growth	2.14%	2.14%
=TFP Growth LECs	4.70%	2.77%
+ IPD	2.79%	2.79%
- TFP Gr in NFB	0.14%	0.14%
= X-Factor	7.35%	5.42%

Note: TFP Gr in NFB is Total Factor Productivity Growth in Non-Farm Business Sector

Source: Computed in Performance-Based Model

Table 8A. TFP, Input Price Differential and X-Factor in Interstate and All LEC Regulated Services: Rates of Growth, 1985-1994 Adjusted for Separations, 1991-1994

	Interstate Access Services	All LEC Regulated Services
Output Growth	6.83%	4.90%
- Input Growth	2.14%	2.14%
+ Separations Adjustment	0.91%	---
= TFP Growth LECs	5.60%	2.77%
+ IPD	2.79%	2.54%
- TFP Gr in NFB	0.14%	0.14%
= X-Factor	8.25%	5.42%

Note: TFP Gr in NFB is Total Factor Productivity Growth in Non-Farm Business

Source: Computed in Performance-Based Model

ATTACHMENT 1

Table A-1. Distribution Statistics: Christensen Data, 1949-93

	Mean	Std Dev	Minimum	Maximum
CPT	4.57556	4.46558	-3.70000	14.60000
CPE	4.70000	2.63292	-1.00000	9.90000
MOODY	6.99689	3.22457	2.62000	14.17000
CPDIFF	-0.12444	4.00472	-7.80000	8.40000

	Sum	Variance	Skewness	Kurtosis
CPT	205.90000	19.94143	0.58044	-0.19033
CPE	211.50000	6.93227	-0.077975	-0.34179
MOODY	314.86000	10.39785	0.41078	-0.70150
CPDIFF	-5.60000	16.03780	0.43396	-0.040337

Table A-2. Distribution Statistics: NERA Data, 1960-93

	Mean	Std Dev	Minimum	Maximum
NPT	4.50294	3.99147	-3.70000	13.70000
NPE	5.19706	2.06023	1.70000	9.50000
MOODY	8.21118	2.74847	4.26000	14.17000
NPDIFF	-0.66471	3.46155	-7.90000	7.60000

	Sum	Variance	Skewness	Kurtosis
NPT	153.10000	15.93181	0.22310	0.067574
NPE	176.70000	4.24454	0.46603	-0.67159
MOODY	279.18000	7.55408	0.34985	-0.34326
NPDIFF	-22.60000	11.98235	0.39864	1.18111

Table A-3. Davidson-MacKinnon T Tests for Normal Distributions of CPT, CPE, MOODY, CPDIFF in Christensen Dataset

Two tailed test. Criterion: $|t| > 1.96$ implies non-normality

	SKEW TEST	KURTOSIS TEST
CPT	1.75737	-0.28812
CPE	-0.23608	-0.51742
MOODY	1.24369	-1.06194
CPDIFF	1.31387	-0.061064

Table A-4. Davidson-MacKinnon T Tests for Normal Distributions of NPT, NPE, MOODY, NPDIFF in NERA Dataset

Two tailed test. Criterion: $|t| > 1.96$ implies non-normality

	SKEW TEST	KURTOSIS TEST
NPT	0.53109	0.080429
NPE	1.10938	- 0.79936
MOODY	0.83282	-0.40856
NPDIFF	0.94896	1.40580

Table A-5. Summary of Unit Root Tests for Christensen Data, 1949-93

Weighted Symmetric Test

	CPT	CPE	MOODY	CPDIFF
Test Statistics	-2.59218	-1.74566	-1.68227	-3.70691
P Value Probability of Unit Root	0.23909	0.79778	0.82663	0.011103
AIC Criterion Optimal Number of lags	2	5	3	2

Table A-6. Summary of Unit Root Tests for NERA Data, 1960-93

Weighted Symmetric Test

	NPT	NPE	MOODY	NPDIFF
Test Statistics	-2.62978	-1.28199	-1.59909	-4.61052
P Value Probability of Unit Root	0.21925	0.94038	0.85943	0.00075339
AIC Criterion Optimal Number of lags	2	5	3	5

Table A-7. Engle-Granger (tau) Cointegration Tests for Fuss Model: Equation 4.1

Model: CPT C CPE DIVEST MOODY

TestStat	P-value	Num.lags
-3.52705	0.31156	2.00000

Model: CPDIFF C DIVEST MOODY

TestStat	P-value	Num.lags
-3.66691	0.13622	2.00000

Model: CPT C CPE D84 MOODY

TestStat	P-value	Num.lags
-3.52705	0.31156	2.00000

Model: CPT C CPE D85 MOODY

TestStat	P-value	Num.lags
-3.01363	0.58033	2.00000

Model: CPT C CPE D86 MOODY

TestStat	P-value	Num.lags
-2.96112	0.60816	2.00000

Model: CPT C CPE D87 MOODY

TestStat	P-value	Num.lags
-3.16921	0.49622	2.00000

Model: CPT C CPE D88 MOODY

TestStat	P-value	Num.lags
-3.14384	0.51000	2.00000

Model: CPT C CPE D89 MOODY

TestStat	P-value	Num.lags
-3.12446	0.52053	2.00000

Model: CPT C CPE D90 MOODY

TestStat	P-value	Num.lags
-2.78960	0.69465	2.00000

Model: CPT C CPE D91 MOODY

TestStat	P-value	Num.lags
-3.60018	0.27818	2.00000

Model: CPT C CPE D92 MOODY

TestStat	P-value	Num.lags
-3.16448	0.49879	3.00000

Model: CPT C CPE D93 MOODY

TestStat	P-value	Num.lags
-4.06978	0.11469	2.00000

Model: CPT C CPE D84 F90 MOODY

TestStat	P-value	Num.lags
-3.22554	0.62656	2.00000

Model: CPT C CPE F84 D90 MOODY

TestStat	P-value	Num.lags
-3.22554	0.62656	2.00000

Table A-8. Engle-Granger (tau) Cointegration Tests for Fuss Model: Equation 4.2

Model: CPDIFF C D84 MOODY

TestStat	P-value	Num.lags
-3.66691	0.13622	2.00000

Model: CPDIFF C D85 MOODY

TestStat	P-value	Num.lags
-3.28582	0.27346	2.00000

Model: CPDIFF C D86 MOODY

TestStat	P-value	Num.lags
-3.20193	0.31134	2.00000

Model: CPDIFF C D87 MOODY

TestStat	P-value	Num.lags
-3.49227	0.19152	2.00000

Model: CPDIFF C D88 MOODY

TestStat	P-value	Num.lags
-3.59648	0.15700	2.00000

Model: CPDIFF C D89 MOODY

TestStat	P-value	Num.lags
-3.46079	0.20359	2.00000

Model: CPDIFF C D90 MOODY

TestStat	P-value	Num.lags
-3.09398	0.36365	2.00000

Model: CPDIFF C D91 MOODY

TestStat	P-value	Num.lags
-3.84512	0.092491	2.00000

Model: CPDIFF C D92 MOODY

TestStat	**P-value**	**Num.lags**
-4.10987	**0.048319**	**2.00000**

Model: CPDIFF C D93 MOODY

TestStat	**P-value**	**Num.lags**
-4.06879	**0.053753**	**2.00000**

Model: CPDIFF C D84 F90 MOODY

TestStat	P-value	Num.lags
-3.19756	0.48085	2.00000

Model: CPDIFF C F84 D90 MOODY

TestStat	P-value	Num.lags
-3.19756	0.48085	2.00000

Table A-9. Engle-Granger (tau) Cointegration Tests for Fuss Model: Equation 4.3

Model: NPT C NPE D84 MOODY

TestStat	P-value	Num.lags
-4.10431	0.10627	2.00000

Model: NPT C NPE D85 MOODY

TestStat	P-value	Num.lags
-3.32287	0.41379	2.00000

Model: NPT C NPE D86 MOODY

TestStat	P-value	Num.lags
-3.30846	0.42139	2.00000

Model: NPT C NPE D87 MOODY

TestStat	P-value	Num.lags
-3.57783	0.28817	2.00000

Model: NPT C NPE D88 MOODY

TestStat	P-value	Num.lags
-3.64921	0.25696	2.00000

Model: NPT C NPE D89 MOODY

TestStat	P-value	Num.lags
-3.87281	0.17205	2.00000

Model: NPT C NPE D90 MOODY

TestStat	P-value	Num.lags
-3.29070	0.43081	2.00000

Model: NPT C NPE D91 MOODY

TestStat	P-value	Num.lags
-3.69114	0.23958	3.00000

Model: NPT C NPE D92 MOODY

TestStat	P-value	Num.lags
-3.72498	0.22611	3.00000

Model: NPT C NPE D93 MOODY

TestStat	P-value	Num.lags
-3.62320	0.26809	3.00000

Model: NPT C NPE D84 F90 MOODY

TestStat	P-value	Num.lags
-3.75378	0.34555	2.00000

Model: NPT C NPE F84 D90 MOODY

TestStat	P-value	Num.lags
-3.75378	0.34555	2.00000

Table A-10. Engle-Granger (tau) Cointegration Tests for Fuss Model: Equation 4.4

Model: NPDIFF C D84 MOODY

TestStat	P-value	Num.lags
-3.87224	0.086893	2.00000

Model: NPDIFF C D85 MOODY

TestStat	P-value	Num.lags
-3.41808	0.21944	2.00000

Model: NPDIFF C D86 MOODY

TestStat	P-value	Num.lags
-3.45191	0.20682	2.00000

Model: NPDIFF C D87 MOODY

TestStat	P-value	Num.lags
-3.78229	0.10651	2.00000

Model: NPDIFF C D88 MOODY

TestStat	P-value	Num.lags
-3.01426	0.40436	3.00000

Model: NPDIFF C D89 MOODY

TestStat	**P-value**	**Num.lags**
-4.05538	**0.055630**	**2.00000**

Model: NPDIFF C D90 MOODY

TestStat	P-value	Num.lags
-3.36059	0.24202	2.00000

Model: NPDIFF C D91 MOODY

TestStat	P-value	Num.lags
-3.37930	0.23452	3.00000

Model: NPDIFF C D92 MOODY

TestStat	P-value	Num.lags
-3.20787	0.30858	3.00000

Model: NPDIFF C D93 MOODY

TestStat	**P-value**	**Num.lags**
-4.48115	**0.016749**	**2.00000**

Model: NPDIFF C D84 F90 MOODY

TestStat	P-value	Num.lags
-3.34087	0.40436	2.00000

Model: NPDIFF C F84 D90 MOODY

TestStat	P-value	Num.lags
-3.34087	0.40436	2.00000

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APPENDIX C

STATEMENT OF M. ISHAQ NADIRI, PH.D.

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