1 factor established in the study entitled "Productivity of the
2 Local Telephone Operating Companies" by Christensen, Schoech
3 and Meitzen ("the Christensen study"). I endorse both the
4 analysis and results of this study. The most recent update of
5 this study concludes that the proper telecommunication
6 productivity factor is 2.1 percent.
7 Q. On what basis do you endorse the Christensen study?
8 A. First, Dr. Christensen, along with Professors Dale
9 Jorgensen (at Berkeley and Harvard), Daniel McFadden (at
10 Berkeley and MIT), Lawrence Lau (at Stanford), and Irwin
11 Diewert (at Chicago and University of British Columbia) and
12 their students, invented most of the production, cost and
13 productivity methods which are used today. Among these
14 methods are the total factor productivity methods, but also,
15 index number theory, that is, the correct way of measuring
16 input and output price changes. These methods are properly
17 applied in the Christensen study.
18 Second, Dr. Christensen is one of the most prolific
19 and highly regarded researchers in the area of production and
20 productivity measures. Indeed, he is one of the most cited
21 and well respected authors in the economics literature.
22 Dr. Christensen is a theoretical and applied econometrician of
23 the first rank.
24 Q. Have you personally reviewed the Christensen study?
25 A. Yes.
26 Q. What are your opinions as to the relevance of this
27 study to the present NRF Reform proceeding?

1 A. To the extent the Commission decides to maintain a
2 productivity adjustment factor, they should use the proper
3 one. Dr. Christensen's study produces an appropriate
4 productivity factor.
5 The methodology of the Christensen study is the same
6 that I would use if I were to do an independent study and
7 analysis of the telecommunications industry. Based upon my
8 knowledge and respect of the individuals performing the study
9 and based upon my review of the study, I have the highest
10 confidence in and agree with the results reported in the
11 Christensen study.
12 Q. You previously stated that the Christensen study
13 uses the correct methodology for measuring input and output
14 changes. What is the correct way of measuring these changes?
15 A. The Christensen study uses GDPPI as the output price
16 adjustment factor, and does not use a similar adjustment of
17 the input prices. This is appropriate. Since the
18 telecommunications industry competes on the competitive market
19 for labor, materials and equipment, and since this equipment
20 is produced in competitive markets, the relevant price index
21 is the overall United States market input price index. Thus,
22 there is no differential between local exchange carrier input
23 prices and overall United States economy input prices that
24 needs to be reflected. Tests performed by the Christensen
25 study and parallel tests performed by National Economic
26 Research Associates ("NERA") showed no evidence of a long run
27 deviation in the series of input prices between the

1 telecommunications industry and the United States economy.
2 Q. What is the issue with regard to comparing the
3 inflation faced by telephone companies in their input prices,
4 versus the inflation that occurs in the general economy?
5 A. This issue has been raised by some parties in other
6 proceedings, and we anticipate that it may also be raised
7 here. Typically, the claim is something like the following:
8 (1) the prices of the inputs that local telephone companies
9 buy face inflation at a lower rate than the general rate of
10 inflation in the economy; so (2) using an economy-wide
11 inflation index for the price cap gives local telephone
12 companies too much of an inflation adjustment; so
13 (3) regulators should increase the productivity offset to
14 adjust for this claimed difference.
15 Q. What is the problem with this claim?
16 A. It is simply wrong, in at least two senses. First,
17 as a matter of fact it is not true that what telephone
18 companies buy is subject to less than average inflation.
19 Second, even if it were true, the suggested remedy is
20 wrong--because in such an unusual situation, the economy would
21 adjust to reduce the gap (which is to say, the purported
22 benefit in this example) so that local telephone companies
23 would never get the opportunity of keeping this claimed
24 differential as extra profits.
25 Q. What needs to be done to test whether the labor,
26 goods and services that local telephone companies buy are
27 facing inflation at an unusually low (or high) rate?

1 A. To test this, we need to look at what is called a
2 price series, which is a set of data developed to show what
3 the prices actually were for the purchase of certain types of
4 goods and services over a period of time. For this analysis
5 we need two price series--the one for the inputs local
6 exchange carriers buy, and the one for the United States
7 economy as a whole. We can then perform a battery of standard
8 statistical tests to compare the two price series, and to see
9 whether they are the same, or different.
10 Q. If the two price series are the same, would you
11 expect to see identical values for each time period?
12 A. No, you would not. Random statistical fluctuations
13 are to be expected, which will make the two sets of data
14 somewhat different. However, if the two price series are the
15 same, then over time you would expect those fluctuations to
16 even out.
17 Q. What would happen if the telecommunications input
18 prices grew at a rate faster than the economy as a whole?
19 A. This is an area where economists have a very good
20 analysis to describe what might happen in the event that
21 telecommunications input prices were deviating from the
22 general economy as a whole, which, as I have already
23 demonstrated, they are not. But just to complete the
24 analysis, I will describe what would happen if for some reason
25 this was the case.
26 Essentially, if input prices were to deviate in this
27 fashion for one sector of the economy, the economy as a whole

1 would adjust to make that deviation smaller and eventually
2 cause it to disappear.
3 If telecommunications input prices grew at a rate
4 faster than the economy as a whole capital and labor would
5 migrate to telecommunications. This would depress prices in
6 the telecommunications market and increase them in the United
7 States market as a whole, thus closing the gap.
8 Similarly, if telecommunications prices grow more
9 slowly than the United States economy as a whole, labor and
10 capital migrates out of the industry. This would increase
11 prices in telecommunications while depressing the prices in
12 the economy as a whole, thus again decreasing any gap. A
13 persistent gap is inconsistent with what we know about both
14 labor and capital markets. The market tends to make similar
15 jobs in the labor market have similar wages. The same is true
16 in equipment markets: Electric motors used in
17 telecommunications cost the same as those in shipping. The
18 computer chips running a Class-5 telecommunication switch cost
19 as much as the same chips monitoring the heating and cooling
20 system in a manufacturing plant. A Pentium sold to GTE costs
21 the same as a Pentium sold to General Motors.
22 Economists speak of such series that move together
23 as being cointegrated and while they may differ in short run
24 fluctuations, over time, they behave in a similar fashion.
25 Q. Have you run any tests of your own to confirm the
26 results of the Christensen study?
27 A. Yes. I ran a very simple cointegration test between

1 the local exchange carrier input price growth series used in
2 the Christensen study and the LEC-United States price series
3 used in the recent FCC price cap proceeding (CC Docket
4 No. 94-1, Appx. F), as well as performing standard
5 Autoregressive Integrated Moving-Average ("ARIMA") analyses on
6 each of the series and the difference between the series.
7 Q. What can you conclude from your test?
8 A. Based upon my test, I conclude that the input series
9 are cointegrated. There is no evidence to support the
10 contention that the telecommunications input price series
11 moves differently than the United States input series except
12 for spurious random fluctuations which can be disregarded as I
13 explain below. My calculations appear in Attachment A.
14 Additionally, rather than merely performing a simple
15 means analysis or regression analysis of the types used by
16 Christensen and NERA, I also performed a complete ARIMA
17 analysis of the difference between the input price series as
18 well as the input price series themselves. My findings
19 support those of the Christensen study, as well as those of
20 NERA. First, there is no evidence the series differ in mean.
21 This means they behave the same way in the long run. Second,
22 the local exchange carrier price input series is quite a bit
23 more volatile than the United States input price series.
24 Third, the only differences between the series are the result
25 of totally random zero-meaned noise.
26 Q. What do such findings mean?
27 A. They mean that there is no long run deviation

1 between the growth in the local exchange carrier input price
2 index and the United States economy input price index. Thus,
3 the Christensen study is correct in not adjusting for spurious
4 deviations in an input price series.
5 Q. Does the productivity factor set forth in the
6 Christensen study include a "stretch" element like that which
7 exists in the Commission's current productivity factor?
8 A. No.
9 Q. Is the use of a "stretch" in a productivity factor
10 appropriate in today's environment?
11 A. No, it is not. A "stretch" factor is merely an
12 arbitrary extension of a productivity factor. In a
13 competitive environment, a productivity factor is undesirable
14 in itself and places an asymmetric burden on the LECs. To
15 place an extra "stretch" on an already burdened LEC has the
16 potential to severely (and perhaps irreparably) harm a LEC.
17 Q. Does this conclude your testimony at this time?
18 A. Yes.

ATTACHMENT A

ARIMA Procedure

Correlations of the Estimates

Parameter	MU	AR1,1	AR1,2
MU	1.000	-0.001	0.010
AR1,1	-0.001	1.000	-0.089
AR1,2	0.010	-0.089	1.000

ARIMA Procedure

Autocorrelation Check of Residuals

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	7.67	4	0.105	-0.011	-0.001	-0.096	-0.098	-0.133	-0.381
12	8.91	10	0.541	0.109	0.061	0.085	0.047	0.018	0.036
18	12.61	16	0.701	-0.015	-0.057	0.075	-0.038	-0.204	-0.016
24	18.52	22	0.674	-0.061	0.130	-0.042	0.088	0.155	-0.052

ARIMA Procedure

Model for variable DIFF

Estimated Mean = 0.61139021

Autoregressive Factors
Factor 1: 1 - 0.10146 B**(1) + 0.14159 B**(2)

NRF . /IEW

OBS	YEAR	USPRICE	TELECOM	DIFF
1	1960	1.7	2.4	-0.7
2	1961	2.9	4.0	-1.1
3	1962	4.5	3.1	1.4
4	1963	3.9	4.9	-1.0
5	1964	5.4	2.4	3.0
6	1965	4.4	2.4	2.0
7	1966	5.5	1.5	4.0
8	1967	2.8	5.0	-2.2
9	1968	6.4	6.1	0.3
10	1969	4.0	2.7	1.3
11	1970	3.2	4.0	-0.8
12	1971	6.6	6.5	0.1
13	1972	6.0	7.6	-1.6
14	1973	8.6	6.6	2.0
15	1974	4.2	4.8	-0.6
16	1975	8.5	9.3	-0.8
17	1976	9.2	9.2	0.0

NRF .VIEW

OBS	YEAR	USPRICE	TELECOM	DIFF
18	1977	7.3	4.80	2.50
19	1978	7.0	7.30	-0.30
20	1979	7.7	2.90	4.80
21	1980	7.0	6.90	0.10
22	1981	9.5	11.00	-1.50
23	1982	3.1	9.30	-6.20
24	1983	6.2	13.70	-7.50
25	1984	6.5	1.80	4.70
26	1985	4.0	0.13	3.87
27	1986	3.8	1.31	2.49
28	1987	3.2	1.71	1.49
29	1988	4.6	-3.21	7.81
30	1989	4.2	-3.68	7.88
31	1990	4.3	11.89	-7.59
32	1991	2.9	1.35	1.55
33	1992	5.1	4.45	0.65

NRF .VIEW

ARIMA Procedure

Name of variable = USPRICE.

Mean of working series = 5.278788
Standard deviation = 2.004352
Number of observations = 33

Autocorrelations

Lag	Covariance	Correlation	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
0	4.017429	1.00000	|***

NRF . VIEW

ARIMA Procedure

Inverse Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1    -0.12097  |                .     **|       .                |
  2    -0.28711  |                .******|       .                |
```

Partial Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1     0.31171  |                .       |******.                |
  2     0.33105  |                .       |*******                |
```

NRF . .VIEW

ARIMA Procedure

Conditional Least Squares Estimation

Parameter	Estimate	Approx. Std Error	T Ratio	Lag
MU	4.77806	0.76450	6.25	0
AR1,1	0.22152	0.17032	1.30	1
AR1,2	0.38657	0.17501	2.21	2

Constant Estimate = 1.37255556

Variance Estimate = 3.48469615
Std Error Estimate = 1.86673409
AIC = 137.701275*
SBC = 142.190798*
Number of Residuals= 33
* Does not include log determinant.

NRF VIEW

ARIMA Procedure

Correlations of the Estimates

Parameter	MU	AR1,1	AR1,2
MU	1.000	-0.092	-0.192
AR1,1	-0.092	1.000	-0.347
AR1,2	-0.192	-0.347	1.000

NRF VIEW

ARIMA Procedure

Autocorrelation Check of Residuals

To Lag	Chi Square	DF	Prob	Autocorrelations						
6	8.08	4	0.089	-0.093	-0.111	0.163	0.217	0.185	-0.265	
12	12.78	10	0.236	-0.026	0.228	0.005	-0.161	-0.130	-0.036	
18	17.00	16	0.386	0.059	-0.192	-0.088	-0.075	0.062	-0.090	
24	19.53	22	0.612	-0.018	-0.078	-0.027	0.107	-0.077	-0.010	

ARIMA Procedure

Model for variable USPRICE

Estimated Mean - 4.77806451

Autoregressive Factors
Factor 1: 1 - 0.22152 B**(1) - 0.38657 B**(2)

ARIMA Procedure

Name of variable = TELECOM.

Mean of working series = 4.671212
Standard deviation = 3.871392
Number of observations - 33

Autocorrelations

```
Lag Covariance Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  0  14.987677    1.00000  |                    |********************|
  1   4.213701    0.28114  |              .     |******.             |
  2   2.372121    0.15827  |              .     |***   .             |
                            "." marks two standard errors
```

ARIMA Procedure

Inverse Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1    -0.21879  |                .   ****|       .                |
  2    -0.08014  |                .     **|       .                |
```

Partial Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1     0.28114  |                .       |******.                |
  2     0.08603  |                .       |**     .                |
```

ARIMA Procedure

Conditional Least Squares Estimation

Parameter	Estimate	Approx. Std Error	T Ratio	Lag
MU	4.60116	1.00943	4.56	0
AR1,1	0.25666	0.18198	1.41	1
AR1,2	0.08930	0.18411	0.49	2

Constant Estimate = 3.00931497

Variance Estimate = 15.0645196
Std Error Estimate = 3.88130385
AIC = 186.012003*
SBC = 190.501525*
Number of Residuals= 33
* Does not include log determinant.

ARIMA Procedure

Correlations of the Estimates

Parameter	MU	AR1,1	AR1,2
MU	1.000	-0.004	-0.041
AR1,1	-0.004	1.000	-0.283
AR1,2	-0.041	-0.283	1.000

ARIMA Procedure

Autocorrelation Check of Residuals

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	2.79	4	0.593	-0.006	-0.015	0.083	0.006	-0.017	-0.242
12	4.74	10	0.908	0.135	-0.052	0.040	-0.007	-0.128	-0.035
18	10.50	16	0.839	-0.210	-0.027	0.064	-0.165	-0.121	-0.010
24	13.15	22	0.929	0.061	0.019	-0.112	0.084	0.052	0.018

ARIMA Procedure

Name of variable - DIFF.

Mean of working series = 0.607576
Standard deviation = 3.445018
Number of observations = 33

Autocorrelations

```
Lag Covariance Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  0  11.868146    1.00000  |                    |********************|
  1   1.055075    0.08890  |              .     |**    .             |
  2  -1.569459   -0.13224  |              .  ***|      .             |
                            "." marks two standard errors
```