REDACTED – FOR PUBLIC INSPECTION

EXHIBIT E

DECLARATION OF DAVID E. M. SAPPINGTON AND WILLIAM P. ZARAKAS

REDACTED – FOR PUBLIC INSPECTION

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Business Data Services in an Internet Protocol Environment	)	WC Docket No. 16-143
	)	
	)	
Investigation of Certain Price Cap Local Exchange Carrier Business Data Services Tariff Pricing Plans	)	WC Docket No. 15-247
	)	
	)	
Special Access for Price Cap Local Exchange Carriers	)	WC Docket No. 05-25
	)	
	)	
AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services	)	RM-10593

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DAVID E. M. SAPPINGTON AND WILLIAM P. ZARAKAS

June 28, 2016

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DECLARATION OF

DAVID E. M. SAPPINGTON AND WILLIAM P. ZARAKAS

I. INTRODUCTION

A. Qualifications.

1. ***David E. M. Sappington***. My name is David E. M. Sappington. As previously established in the record,[1] I hold the titles of Eminent Scholar in the Department of Economics and Director of the Robert F. Lanzillotti Public Policy Research Center, both at the University of Florida. I have served as the Chief Economist of the U.S. Federal Communications Commission (the "Commission" or "FCC") and as the President of the

[1] Declaration of David Sappington, appended as Attachment 1 to the Reply Comments of Sprint Corporation, WC Docket No. 05-25 (filed Feb. 19, 2016; revised public version submitted April 11, 2016).

Industrial Organization Society. I presently hold positions on the editorial boards of five major journals, including the Journal of Regulatory Economics, the RAND Journal of Economics, and the Journal of Economics and Management Strategy. My research focuses on the design and implementation of regulatory policy. I have published more than 150 articles in leading journals in the profession and have coauthored a book entitled Designing Incentive Regulation for the Telecommunications Industry.

2. ***William P. Zarakas***. My name is William P. Zarakas. As previously established in the record,[2] I am a Principal with The Brattle Group, an economics consulting firm, where I work primarily on economic and regulatory matters concerning the communications and energy industries. I have been involved in the economic analysis of issues facing these industries for roughly 30 years. I have provided reports and/or testimony before the FCC concerning a range of issues, including market share and churn analyses, cost models, foreclosure and bargaining models, and pole attachments matters.

B. Purpose of this Declaration.

3. Certain incumbent local exchange carriers ("LECs") in the United States currently face a ceiling on the prices they can charge for regulated business data services ("BDS") delivered via time division multiplexing ("TDM"). The ceiling, which takes the form of a price cap index, was explicitly managed during and before the CALLS plan.[3] However,

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[2] Declaration of William P. Zarakas and Susan M. Gately, appended as Attachment 2 to Comments of Sprint Corporation, WC Docket No. 05-25 (filed Jan. 27, 2016; revised public version submitted April 11, 2016).

[3] *See Access Charge Reform; Price Cap Performance Review for Local Exchange Carriers; Low-Volume Long-Distance Users; Federal-State Joint Board on Universal Service*, Sixth Report and Order in CC Docket Nos. 96-262 and 94-1, Report and Order in CC Docket No. 99-249, Eleventh Report and Order in CC Docket No. 96-45, 15 FCC Rcd. 12962, ¶¶ 35, 149 (2000) ("*CALLS Order*") (five-year CALLS plan reduced the X-factor to the gross

although the Commission "intended the CALLS plan to run only until June 30, 2005, the Commission has not acted to remove this freeze" and revise the price cap index.[4] Based in part on the record in this proceeding, the Commission now believes it "should continue to apply price caps to business data services now subject to price cap regulation to the extent that . . . price regulation is necessary[.]"[5]

4. The purpose of this declaration is two-fold: (i) to explain how the prevailing price cap index for BDS delivered via TDM should be re-set at the outset of the new price cap regime; and (ii) to identify the X-factor that should be employed in the initial phase of the new regime.[6]

C. Key Conclusions.

5. We conclude that the prevailing price cap index should be reduced by at least 25.2 percent at the outset of the new price cap regime. This adjustment reflects a conservative estimate of the extent to which the relevant LECs (the "price cap LECS") have experienced productivity gains in excess of input price increases in the supply of BDS since 2005. We also conclude that an X-factor of at least 4.4 percent should be

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domestic product price index in its final year, "essentially . . . freez[ing]" special access price caps after 2003).

4 *Business Data Services in an Internet Protocol Environment; Investigation of Certain Price Cap Local Exchange; Carrier Business Data Services Tariff Pricing Plans; Special Access for Price Cap Local Exchange Carriers; AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services*, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, and 05-25, RM-10593, FCC 16-54, ¶ 349 (rel. May 2, 2016) ("*BDS Order & FNPRM*").

5 *Id.* ¶ 351.

6 The X-factor is the rate at which the price cap index declines annually during the price cap regime after adjusting for the realized rate of economy-wide inflation.

employed in the initial phase of the new price cap regime. This value of the X-factor represents a conservative estimate of the extent to which the price cap LECs are likely to experience more rapid productivity growth and less rapid input price growth than other firms in the U.S. economy in the near future.

D. Outline of this Declaration.

6. This declaration proceeds as follows. Section II explains why the price cap index for BDS should be lowered by at least the extent to which the price cap LECs have experienced productivity gains in excess of input price increases in the provision of BDS since 2005. Section III identifies the publicly available data set that permits the best estimate of relevant changes in productivity and input prices. Section III also explains how these data can be employed to determine an appropriate revision of the price cap index for BDS delivered via TDM. Section IV explains how these data and additional publicly available data can be employed to determine an appropriate X-factor for the first phase of the new price cap regulation regime. Section V presents concluding observations.

II. THE PRINCIPLES FOR RE-SETTING THE PRICE CAP INDEX

A. The Merits of Price Cap Regulation.

7. Price cap regulation constrains the rate at which the prices an enterprise charges for its regulated services can increase over time. In the absence of an earnings sharing provision, price cap regulation implements this constraint without explicitly linking authorized prices to contemporaneous realized costs, including capital costs. The absence of such linkage offers at least two benefits relative to rate of return regulation. First, it limits the regulated firm's incentive to increase investment solely to increase its

rate base and thereby secure higher levels of profit. Second, it implies that the regulated enterprise is able to retain any cost savings it achieves in the form of higher profit during the price cap regime. Consequently, price cap regulation can provide relatively strong incentives for innovation, cost reduction, and productivity growth. In part for these reasons, price cap regulation has been widely deployed in telecommunications sectors throughout the world.[7]

B. Replicating the Discipline of Competitive Markets.

8. An important function of price cap regulation is to replicate the discipline of competitive markets when that discipline is lacking.[8] Therefore, to determine an appropriate formulation of price cap regulation for BDS, it is important to determine the restraints that competition would impose on BDS prices.

9. Competition drives prices to the level of efficient production costs. In particular, competition compels industry suppliers to pursue productivity gains and to pass these gains on to consumers in the form of lower prices.[9] Competition also permits price increases to the extent that all competing industry suppliers experience unavoidable increases in the prices of the inputs they employ in the production process.

10. By driving prices to the level of production costs, competition limits industry suppliers to

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[7] *See* David E.M. Sappington and Dennis L. Weisman, *Price Cap Regulation: What Have We Learned from Twenty-Five Years of Experience in the Telecommunications Industry?*, *in* J. REG. ECONS., at 38(3), 227-57 (Dec. 2010).

[8] *See* Alfred E. Kahn, *The Economics of Regulation: Principles and Institutions Volume 1: Economic Principles* 17 (John Wiley & Sons, Inc. 1970) ("[T]he single most widely accepted rule for the governance of the regulated industries is to regulate them in such a way as to produce the same results as would be produced by effective competition, if it were feasible.").

[9] A firm's productivity is the ratio of the outputs it produces to the inputs it employs to produce the outputs.

a normal profit, *i.e.*, to the minimum level of profit required to ensure that the suppliers can continue to attract capital on reasonable terms and, as a result, will continue to serve the market. Thus, competition secures for consumers the lowest possible prices that are consistent with the ongoing, efficient operation of industry suppliers. If the prices that a firm charges for its products are initially set to secure a normal profit, then the firm will continue to earn a normal profit if its prices increase at a rate equal to the difference between the rates at which its input prices rise and its productivity increases.[10]

11. To express this conclusion formally, let $\dot{P}$ denote the rate at which the firm's prices increase. Also let $\dot{T}$ denote the rate at which the firm's total factor productivity ("TFP") increases, and let $\dot{W}$ denote the rate at which the firm's input prices rise. Then, if the firm's prices are initially set to ensure that the firm earns a normal profit, the firm will continue to earn a normal profit if its prices increase at the rate:

$$\dot{P} \;=\; \dot{W} - \dot{T}\,. \qquad (1)$$

12. Equation (1) identifies the appropriate manner in which to re-set the price cap index at the outset of the new regime for regulating the prices of BDS delivered via TDM. If the price cap index that prevailed at the conclusion of the CALLS plan in 2005 limited the price cap LECs to a normal profit on the provision of BDS, then the adjustment specified in equation (1) would allow them to earn a corresponding normal profit at the start of the new price cap regime (which presumably will take place before the start of 2017). Specifically, the price cap index should be reduced by the difference between the extent to which the price cap LECs' input prices have increased and their productivity has

[10] Appendix A provides a formal proof of this conclusion.

increased in the provision of BDS between 2005 and 2016.[11]

III. MEASURING PRODUCTIVITY AND INPUT PRICE CHANGES

A. The Available Data.

13. In the past, the Commission has employed data reported by the price cap LECs in the Automated Reporting Management Information System ("ARMIS") to measure historic productivity and input price growth rates. Input and output data specific to price cap LEC switched wireline services and BDS are available in the ARMIS through 2007. However, these data are not publicly available for subsequent years. Consequently, we cannot calculate productivity and input price growth rates for years after 2007 using the same data series that the Commission employed prior to the *CALLS Order*.[12]

14. Proxies for these ideal data are available, though. Government agencies in the U.S. – most notably the Bureau of Economic Analysis ("BEA") and the Bureau of Labor Statistics ("BLS") – and their counterparts in other Organisation for Economic Co-operation and Development countries collect data that measure inputs and outputs in many industries.[13] Academic researchers have compiled these data within a common

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[11] If the prices the price cap LECs charged for BDS exceeded costs in 2005, then a more pronounced reduction in the price cap index would be required to ensure that the index permits only a normal profit at the start of the upcoming price cap regime. *See* discussion *infra* at Section III.E.

[12] The *CALLS Order* "transform[ed] the X-factor from a productivity factor into a transitional mechanism that operate[d] to reduce rates at a certain pace, and it would not be linked to a specific measure of productivity." *CALLS Order* ¶ 140.

[13] The U.S. Bureau of Economic Analysis and the U.S. Bureau of Labor Statistics together maintain time series of input, output, and pricing data. *See Industry Economic Accounts*, U.S. Dep't of Commerce, Bureau of Econ. Analysis (Apr. 21, 2016), http://www.bea.gov/industry/; *Multifactor Productivity*, U.S. Dep't of Labor, Bureau of Labor Statistics, http://www.bls.gov/mfp/ (last visited June 6, 2016).

framework to produce cross-industry and cross-country measures of productivity. Two research initiatives in particular – EU KLEMS and World KLEMS[14] – provide archives of this data that are publicly available. The acronym KLEMS refers to the key variables in an analysis of TFP: capital (K), labor (L), energy (E), materials (M), and service (S).

15. The TFP data developed by the BEA and the BLS are not ideal for the present purpose because they commingle statistics from the telecommunications and broadcasting industries. The World KLEMS data remove the broadcasting component of these data, but commingle the resulting data with data from the postal industry (in order to maintain consistency with a long-standing time series of corresponding data).[15] The EU KLEMS data, which are presently available for the years 1998 – 2010, are best suited to the task at hand because they remove the broadcasting component of the BEA/BLS data without commingling the resulting data with data from other industries.[16]

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[14] The productivity calculations in the EU KLEMS and the World KLEMS data conform to respected international standards. *See* Dale W. Jorgenson, Mun S. Ho, and Jon Samuels, *A Prototype Industry-Level Production Account for the United States, 1947-2010*, presented at the Second World KLEMS Conference (Harvard University) (Aug. 9, 2012) (providing a description of the World KLEMS initiative); Mary O'Mahony and Marcel P. Timmer, *Output, Input and Productivity Measures at the Industry Level: The EU KLEMS Database*, *in* ECON. J., at 119(538), F374-F403 (June 2009) (providing a description of the EU KLEMS database).

[15] *World KLEMS Data*, World KLEMS, http://www.worldklems.net/data.htm#statistical (last visited June 6, 2016).

[16] *See EU KLEMS Growth and Productivity Accounts: Data in the ISIC Rev. 4 Industry Classification*, EU KLEMS (Oct. 16, 2012), http://www.euklems.net/eukISIC4.shtml. The U.S. telecommunications industry in the EU KLEMS data reflects NAICS (North American Industry Classification System) industry code 517, which includes wired, terrestrial wireless, and satellite suppliers of telecommunications services, as well as resellers of these services. *See 2012 NAICS: 517 – Telecommunications*, U.S. Census Bureau, https://www.census.gov/econ/isp/sampler.php?naicscode=517&naicslevel=3 (last visited June 6, 2016).

16. Figure 1 presents the EU KLEMS, World KLEMS, and BEA/BLS TFP indices. The three indices follow similar trends: increasing productivity between 2001 and 2008, a decline in productivity in 2009 following the "Great Recession," and varying degrees of post-recession recovery. Between 2005 and 2010, the BEA/BLS broadcasting and telecommunications index lies below both the EU KLEMS telecommunications index and the World KLEMS postal and telecommunications index. This relationship may well reflect limited productivity growth (or even declining productivity) in the broadcasting sector during this period.[17]

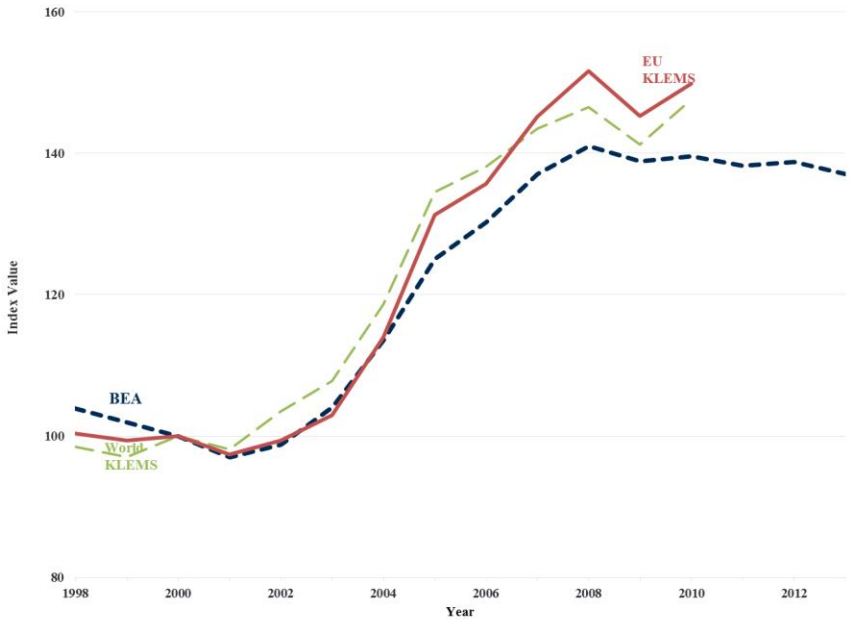

Figure 1. Total Factor Productivity Indices for U.S. Telecommunications.

[17] Although the EU KLEMS data series does not provide data specific to the broadcasting industry, it does provide data for the publishing and broadcasting industries combined. These data report that, between 2005 and 2010, productivity in the publishing and broadcasting sectors declined by 5 percent, while productivity in the telecommunications sector increased by 14 percent. Productivity growth rates were comparable in the two sectors between 2000 and 2005. These findings suggest that the relatively limited TFP growth in the broadcasting and telecommunications industries reported in the BEA/BLS data may well reflect meager TFP growth (or even declining TFP) in the broadcasting industry.

Sources. BEA: www.bls.gov/mfp, Broadcasting & Telecommunications.
EU KLEMS: www.euklems.net, Telecommunications.
World KLEMS: www.worldklems.net, Postal & Telecommunications.

B. The EU KLEMS Time Series Provides the Best Available Productivity Data.

17. While none of these data series reports data that pertain exclusively to the supply of BDS delivered via TDM, the EU KLEMS data offer the distinct advantage of not commingling data from the telecommunications industry with data from other industries. To avoid drawing inappropriate inferences about productivity trends in the telecommunications industry because of distinct and irrelevant productivity trends in the postal or broadcasting industries, we employ the EU KLEMS data in the calculations reported below.

18. Table 1 reports the entire time series of TFP and input price data for the U.S. telecommunications industry that is available in the EU KLEMS data.

Year	Productivity Index	Input Price Index
1998	76.4	97.2
1999	75.7	96.9
2000	76.1	97.1
2001	74.2	96.9
2002	75.7	96.6
2003	78.4	97.6
2004	86.8	98.3
2005	100.0	100.0
2006	103.3	102.2
2007	110.5	103.1
2008	115.5	105.6
2009	110.6	105.7
2010	114.1	107.0

Table 1. U.S. Telecommunications Productivity and Input Prices.

Source. EU KLEMS: www.euklems.net, Telecommunications.

C. The Rationale for at Least a 25.2 Percent Reduction in the Price Cap Index.

19. Because the EU KLEMS data presently are available only for the years 1998 – 2010, we cannot simply employ data from the relevant eleven-year period (2005 – 2016) to perform the calculation specified in equation (1). Instead, we employ the entire time series of EU KLEMS data to calculate the average annual productivity and input price growth rates that prevailed between 1998 and 2010. We then apply these calculated average annual growth rates over an eleven-year period to determine the extent to which the price cap index for BDS should be reduced at the start of the new price cap regime.

20. Specifically, we employ the EU KLEMS data to calculate compound annual growth rates for productivity and input prices in the U.S. telecommunications industry between 1998 and 2010. A compound annual growth rate ("CAGR") is the hypothetical constant annual rate at which a variable must increase during a specified time period to change from its initial value to its final value. Formally, the CAGR for a variable that begins at value V_I and, T years later, attains value V_F is:

$$CAGR = \left[\frac{V_F}{V_I}\right]^{\frac{1}{T}} - 1. \qquad (2)$$

21. Substituting the relevant data from Table 1 into equation (2) reveals that the CAGR for productivity in the U.S. telecommunications industry between 1998 and 2010 is 3.4 percent (because $[114.1/76.4]^{\frac{1}{12}} - 1 = 0.034$). The corresponding CAGR for input prices is 0.8 percent (because $[107.0/97.2]^{\frac{1}{12}} - 1 = 0.008$).

22. Substituting these CAGRs into equation (1) implies that the price cap index for BDS should be reduced by 2.6 percent (= 3.4% – 0.8%) each year between 2006 and 2016 to ensure a normal profit for the price cap LECs at the start of the new price cap regime.

When this 2.6 percent annual reduction is applied in each of these eleven years, the price cap index is reduced by 25.2 percent ($= 1 - (1 - .026)^{11}$).

D. Use of the Entire EU KLEMS Data Series is Appropriate.

23. Conceivably, one might consider employing subsets of the EU KLEMS data series to obtain estimates of the rates at which TFP and input prices in the supply of BDS have changed between 2005 and 2016. For example, one might consider employing only data from the 2005 – 2010 time period on the grounds that the current concern is with TFP and input price changes that have occurred since 2005. However, the 2005 – 2010 time period encompasses the Great Recession. Therefore, data from this time period may substantially understate productivity gains in the U.S. telecommunications industry between 2005 and 2016, a period that includes several years of post-recession recovery.

24. One might also consider employing only the most recent eleven years of data in the EU KLEMS time series on the grounds that the present goal is to secure estimates of productivity and input price growth rates for the eleven-year period between 2005 and 2016. This approach could be appropriate if there is reason to believe that the most recent data in the EU KLEMS time series is the best predictor of the 2011 – 2016 data that is not yet available. However, we do not have strong reason to believe that any specific subset of the EU KLEMS data series is more likely than the entire series to capture performance in the U.S. telecommunications industry between 2011 and 2016. Therefore, we employ the entire data series.[18]

[18] If only the 2000 – 2010 subset of the EU KLEMS time series were employed to calculate CAGRs for productivity and input prices, the appropriate reduction in the price cap index would be 29.7 percent rather than 25.2 percent.

E. A Reduction in the Price Cap Index of More Than 25 Percent May be Appropriate.

25. There are at least three reasons why the identified 25.2 percent reduction in the price cap index may be unduly conservative in the sense that it will allow the price cap LECs to secure more than a normal profit at the outset of the new price cap regulation regime.

26. First, productivity growth rates for the entire telecommunications industry may well understate the corresponding growth rates for BDS delivered via TDM. Ms. Susan Gately has employed ARMIS data to estimate productivity growth rates for BDS for the period 2000 – 2004.[19] Ms. Gately calculated a 14.7 percent average annual growth rate for BDS productivity,[20] which is more than four times the identified 3.4 percent growth rate of productivity in the U.S. telecommunications industry. If productivity in the supply of BDS has increased substantially faster than productivity in the U.S. telecommunications sector in recent years, then the price cap index should be reduced substantially more than 25.2 percent in order to reduce price cap LEC profit to a normal level at the start of the new price cap regime.

27. Second, the identified 25.2 percent reduction in the price cap index is predicated on the assumption that the price cap LECs were earning a normal profit in the supply of BDS in 2005. Evidence of above-normal profit at this time would indicate that the price cap index would need to be reduced by more than 25.2 percent to limit the price cap LECs to a normal profit at the start of the upcoming price cap regime. Ms. Gately's analysis

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[19] Reply Declaration of Susan M. Gately, attached to the Reply Comments of Ad Hoc Telecommunications Users Committee, WC Docket No. 05-25 (filed July 29, 2005).

[20] *Id.* at Appendix 1a, Table 2, column D (14.71 = [10.760 + 16.684 + 16.101 + 13.891 + 16.114] / 5).

provides such evidence. She estimates that between 2000 and 2004, an X-factor of 11.01 percent would have been required to preclude an increase in the profit the price cap LECs secured in the provision of BDS.[21] In contrast, the X-factor for BDS never exceeded 6.5 percent during or prior to the CALLS plan.[22] This evidence suggests that the price cap LECs enjoyed above-normal profit in 2005, so a reduction in the price cap index of more than 25.2 percent would be required to prevent the price cap LECs from continuing to enjoy these above-normal earnings on an ongoing basis.

28. Third, the identified 0.8 percent input price growth rate in the U.S. telecommunications industry may well exceed the growth rate of the prices of inputs employed to supply BDS. The Commission has employed data from the Connect America Cost Model ("CACM") and other sources to estimate the rate of change of the prices of inputs employed to supply residential broadband and voice services using a fiber-to-the-premise network.[23] The Commission estimates that the CAGR for these input prices is between – 1.84 percent and 0.60 percent.[24]

29. It seems likely that the prices of inputs employed to supply BDS and the prices of inputs

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21 *Id.* at Appendix 1a, Table 1 (column C) and Table 2 (column I). The price cap LECs at the time were Bellsouth, Qwest, SBC, and Verizon.

22 The highest X-factor adopted before the CALLS plan was the 6.5 percent X-factor adopted in 1997. *See Price Cap Performance Review for Local Exchange Carriers; Access Charge Reform*, Fourth Report and Order in CC Docket No. 94-1 and Second Report and Order in CC Docket No. 96-262, 12 FCC Rcd. 16642 (1997) ("*Price Cap Review Order*"). "The CALLS X-factor for special access was 3.0 percent in 2000, and increased to 6.5 percent for 2001, 2002, and 2003. For the final year of the CALLS plan (July 1, 2004 – June 30, 2005), the special access X-factor was set equal to inflation[.]" *BDS Order & FNPRM* ¶19.

23 *BDS Order & FNPRM* ¶¶ 408-11.

24 Appendix B explains this conclusion.

employed to supply residential data services increase at similar rates.[25] Therefore, the prices of the inputs employed to supply BDS may be increasing at a rate closer to 0.60 percent annually than to the 0.8 percent annual increase estimated above. (Indeed, these prices may even be *declining* by as much as 1.84 percent annually.) If the CAGR of productivity in the supply of BDS between 2006 and 2016 were 3.4 percent as estimated above, and if the corresponding CAGR of input prices were 0.60 percent, then the price cap index would need to decline by 26.8 percent, not 25.2 percent, to limit the price cap LECs to a normal profit at the start of the new price cap regime.[26] The corresponding decline in the price cap index would be 44.7 percent if the corresponding CAGR of input prices were – 1.84 percent.[27]

IV. SPECIFYING THE X-FACTOR

A. The Elements of an X-Factor.

30. Conceivably, one might employ equation (1) to determine the maximum rate at which BDS prices can increase during the upcoming initial phase of price cap regulation. Specifically, one might estimate the rates at which the price cap LECs' TFP and input prices in the provision of BDS will increase during the upcoming phase of price cap

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[25] As the Commission observes, "there are no reasons to think that either (1) the underlying cost categories of the CACM or (2) the rates of change in input prices of these cost categories would be significantly different for business data services than for residential data services." *BDS Order & FNPRM* ¶ 409.

[26] If $\dot{T} = .034$ and $\dot{W} = .006$, then $\dot{W} - \dot{T} = -.028$. Therefore, equation (1) indicates that the price cap index should decline by 2.8 percent annually. This annual decline produces a 26.9 percent cumulative decline over an eleven-year period because ($1 - [1 - .028]^{11} = 1 - .732 = .268$).

[27] If $\dot{T} = .034$ and $\dot{W} = -.0184$, then $\dot{W} - \dot{T} = -.0524$. Therefore, equation (1) indicates that the price cap index should decline by 5.24 percent annually. This annual decline produces a 44.7 percent cumulative decline over an eleven-year period because ($1 - [1 - .05254]^{11} = 1 - .553 = .447$).

regulation. After initially setting BDS prices to reflect prevailing costs, one could then limit the rate at which these prices rise during the upcoming price cap regime to the difference between the rates at which relevant input prices and TFP are predicted to increase. This approach would be conceptually sound.

31. However, in practice, it can be difficult to predict accurately the rates at which productivity and input prices will increase in an industry. In contrast, it often is less difficult to forecast the extent to which productivity and input prices will increase more rapidly in the industry than in the economy as a whole.[28] Therefore, price cap regulation typically specifies the rate at which prices in the regulated industry can increase relative to the rate at which prices increase in the economy as a whole.[29]

32. Specifically, price cap regulation typically permits prices in the regulated industry to increase at the rate of economy-wide price inflation, less an off-set, called the X-factor. The X-factor reflects the extent to which: (i) productivity in the regulated industry is expected to increase more rapidly than productivity in the economy as a whole; and (ii) input prices are expected to increase less rapidly in the regulated industry than in the economy as a whole.[30]

33. To state this implementation of price cap regulation formally, let $\dot{T}^I$ and $\dot{T}^E$, respectively, denote the rates at which TFP is increasing in the regulated industry and in the economy

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[28] This forecast only requires accurate predictions of industry deviations from economy-wide trends that are observed during the price cap regime. In contrast, use of the approach identified in equation (1) would require precise predictions of the actual magnitudes of industry-specific trends that will prevail throughout the regime.

[29] This is the approach the Commission has always employed to implement price cap regulation. *See Policy and Rules Concerning Rates for Dominant Carriers*, Second Report and Order, 5 FCC Rcd. 6786, ¶¶ 47-54 (1990).

[30] Appendix A explains the rationale for this approach in more detail.

as a whole. Also let $\dot{W}^I$ and $\dot{W}^E$, respectively, denote the rates at which input prices are increasing in the regulated industry and in the economy as a whole. Then the X-factor is:

$$X = \left(\dot{T}^I - \dot{T}^E\right) + \left(\dot{W}^E - \dot{W}^I\right). \quad (3)$$

Price cap regulation permits a weighted average of regulated prices (the price cap index) to increase at the rate:

$$\dot{P} = \dot{P}^E - X, \quad (4)$$

where $\dot{P}^E$ denotes the economy-wide rate of price inflation.

B. The Rationale for an X-Factor of at Least 4.4 Percent.

34. To determine an X-factor to employ in the upcoming phase of price cap regulation for BDS delivered via TDM, we again employ the entire EU KLEMS data series to calculate CAGRs for productivity and input prices in the telecommunications industry ($\dot{T}^I$ and $\dot{W}^I$). We also employ publicly available data series from the same time period (1998 – 2010) to calculate CAGRs for productivity and input prices in the economy as a whole ($\dot{T}^E$ and $\dot{W}^E$). Specifically, we employ BLS data on input prices and TFP in the non-farm sectors of the U.S. economy that are drawn from the same source that the Commission has employed historically.[31] These data are recorded in Table 2.

[31] *See Price Cap Review Order* ¶¶ 106, 133-43 (using BLS input price data and the total factor productivity indices to conduct a TFP study for the purpose of deriving an X-factor). It is appropriate to employ BLS data here because the present task is to measure productivity and input price growth rates for the entire U.S. economy, not for particular industries. Consequently, concerns about undesirable commingling of data from different industries are not an issue in the present task.

Year	Productivity Index	Input Price Index
1998	89.21	73.22
1999	90.94	75.44
2000	92.38	78.13
2001	92.85	79.83
2002	94.82	81.92
2003	96.90	84.92
2004	99.30	89.31
2005	100.81	93.64
2006	101.11	96.78
2007	101.69	100.03
2008	100.34	101.46
2009	100.00	100.00
2010	102.93	103.86

Table 2. Productivity and Input Prices in the Non-Farm U.S. Economy.

Source. Bureau of Labor Statistics, Table XG 4-2, "Net Multifactor Productivity and Costs, 1987 – 2015, Private Non-Farm Business Sector (Excluding Government Enterprises)," http://www.bls.gov/mfp/#data.

35. The data in Table 2 imply that the CAGR for productivity in the U.S. economy was 1.2 percent (= $[102.93/89.21]^{\frac{1}{12}} - 1$) between 1998 and 2010. The corresponding CAGR for input prices in the U.S. economy was 3.0 percent (= $[103.86/73.22]^{\frac{1}{12}} - 1$). Therefore, during this period, annual productivity growth in the telecommunications industry exceeded the corresponding annual growth in the U.S. economy by 2.2 percent (= 3.4% – 1.2%). Furthermore, annual input price growth in the U.S. economy exceeded annual input price growth in the U.S. telecommunications industry by 2.2 percent (= 3.0% – 0.8%). Therefore, from equation (3), the corresponding X-factor is 4.4 percent (= 2.2% + 2.2%).

C. The Rationale for a Higher X-Factor.

36. A 4.4 percent X-factor will understate the X-factor required to limit the price cap LECs to a normal expected profit during the upcoming period of price cap regulation if: (i) productivity growth in the supply of BDS during this period is likely to exceed the productivity growth in the entire U.S. telecommunications industry between 1998 and 2010; or (ii) the prices of inputs employed in the provision of BDS are likely to increase less rapidly during the upcoming price cap period than the prices of inputs employed in the entire U.S. telecommunications industry between 1998 and 2010. Therefore, if the Commission believes that such faster productivity growth or slower input price growth is likely to prevail in the supply of BDS during the upcoming price cap period, then it should set an X-factor in excess of the identified 4.4 percent.

37. To illustrate, recall that data from the CACM and other sources suggest that the prices of inputs employed to supply residential broadband and voice services increase at an annual rate between – 1.84 percent and 0.60 percent.[32] First suppose the upper bound of this range (0.60 percent) serves as the estimate of the annual rate at which input prices in the supply of BDS will increase ($\dot{W}^I$) during the upcoming initial phase of price cap regulation. Further suppose that the estimates of the other growth rates identified above remain unchanged. Specifically, suppose the annual rate of productivity growth in the supply of BDS in the upcoming price cap period ($\dot{T}^I$) is expected to be 3.4 percent, the corresponding productivity growth rate in the U.S. economy ($\dot{T}^E$) is 1.2 percent, and the

[32] Recall the discussion in Section III.E above.

annual input price growth rate in the U.S. economy ($\dot{W}^E$) is 3.0 percent. From equation (3), the appropriate X-factor in this case is 4.6 percent (= 3.4% – 1.2% + 3.0% – 0.6%).

38. Now suppose the lower bound of the identified range of input price growth rates (–1.84 percent) serves as the estimate of $\dot{W}^I$ for the upcoming phase of price cap regulation. If all other elements of the X-factor in equation (3) remain unchanged (so $\dot{T}^I = 3.4\%$, $\dot{T}^E = 1.2\%$, and $\dot{W}^E = 3.0\%$), then the appropriate X-factor is 7.0 percent (= 3.4% – 1.2% + 3.0% + 1.8%).[33]

D. Setting the X-Factor in the Future.

39. The X-factor that the Commission establishes will need to be revisited at the conclusion of each phase of the new price cap regime. To facilitate future determination of this critical policy parameter, it would be reasonable to require the price cap LECs to report relevant BDS-specific data to the Commission on an ongoing basis. Such data would enable the Commission to calculate productivity and input price growth rates that are instrumental in the design of an effective system of price cap regulation for BDS. These data would thereby allow the Commission to implement price cap regulation that continuously protects consumers of BDS while providing price cap LECs with strong incentives for innovation, cost reduction, and productivity growth.

V. CONCLUSIONS

40. Our analysis indicates that the price cap index for regulated BDS delivered via TDM should be reduced by at least 25.2 percent at the start of the new price cap regulation

[33] If the midpoint of the identified range of input price growth rates (–1.24 percent) serves as the estimate of $\dot{W}^I$ for the upcoming phase of price cap regulation and if all other elements of the X-factor in equation (3) remain unchanged (so $\dot{T}^I = 3.4\%$, $\dot{T}^E = 1.2\%$, and $\dot{W}^E = 3.0\%$), then the appropriate X-factor is 6.4 percent (= 3.4% – 1.2% + 3.0% + 1.2%).

regime. Our analysis also indicates that an X-factor of at least 4.4 percent should be employed in the first phase of this regime.

41. A more substantial reduction in the price cap index and a larger X-factor are appropriate to the extent that: (i) productivity growth in the provision of BDS in the near future is likely to exceed productivity growth in the U.S. telecommunications industry between 1998 and 2010; and (ii) the prices of inputs employed to supply BDS in the near future are likely to increase less rapidly than the prices of inputs employed in the entire U.S. telecommunications industry increased between 1998 and 2010. A more substantial reduction in the price cap index is also appropriate to the extent that the prices of BDS delivered via TDM exceeded corresponding production costs in 2005.

42. The Commission has already observed that the prices of inputs employed in the provision of BDS may well be increasing more slowly than input prices increased between 1998 and 2010 in the U.S. telecommunications sector. This consideration alone indicates that it may be appropriate to reduce the price cap index by as much as 44.7 percent at the start of the new price cap regime and to set an X-factor as high as 7.0 percent for the initial phase of the regime.[34]

43. The price cap LECs have the right to employ their proprietary data to demonstrate that a proposed price cap plan would not provide a reasonable opportunity to earn a normal profit on the supply of BDS. Consequently, the Commission has no reason to implement a revision of the price cap index or an X-factor that is unduly conservative. Less conservative action in this regard can help to ensure a price cap regulation policy that

[34] Recall the discussions in Sections III.E and IV.C above.

better serves BDS customers (and thus the U.S. economy) without risk of reducing price cap LEC profit below a normal level.

Appendix A. Derivation of the X-Factor[35]

The purpose of this Appendix is to explain the logic that underlies equations (1), (3), and (4) above. Specifically, this Appendix first explains why a firm that is initially earning a normal profit (*i.e.*, zero "economic profit") will continue to earn a normal profit if its prices increase at a rate equal to the difference between the rates at which its input prices rise and its productivity increases. This Appendix then explains why an efficient regulated firm can reasonably be expected to earn a normal profit on an ongoing basis if its prices are set initially to ensure a normal profit, and its prices are subsequently required to change at a rate ($\dot{P}$) equal to the difference between the prevailing rate of economy-wide price inflation and an X-factor (X), *i.e.*,

$$\dot{P} \;=\; \dot{P}^E - \; X \;, \tag{A1}$$

where the X-factor is the sum of: (i) the difference between the total factor productivity (TFP) growth rate in the regulated industry ($\dot{T}^I$) and the TFP growth rate in the rest of the economy ($\dot{T}^E$); and (ii) the difference between the input price growth rate in the rest of the economy ($\dot{W}^E$) and the input price growth rate ($\dot{W}^I$) in the regulated industry, *i.e.*, where

$$X \;= \left(\dot{T}^I - \; \dot{T}^E \right) + \left(\dot{W}^E - \dot{W}^I \right) . \tag{A2}$$

To demonstrate these conclusions, observe first that a firm's profit (Π) is the difference between its revenues (R) and its costs (C). When a firm produces n services with m inputs, the firm's profit from regulated operations is:

$$\Pi \;=\; \mathrm{R} - \; \mathrm{C} \;=\; \sum_{i=1}^{n} p_i \, q_i \; - \; \sum_{j=1}^{m} w_j \, v_j \;, \tag{A3}$$

where p_i = the unit price of the i^{th} regulated service;

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[35] The analysis in this Appendix is drawn from Jeffrey I. Bernstein and David E. M. Sappington, *Setting the X Factor in Price Cap Regulation Plans in* J. REG. ECONS., at 16(1), 5-25 (July 1999).

q_i = the quantity of the i^{th} regulated service that the firm sells;

w_j = the unit price of the j^{th} input employed in production; and

v_j = the number of units of the j^{th} input employed by the firm.

To determine how the firm's profit changes as its inputs, outputs, input prices, and output prices all change, take differentials (denoted by "d") in expression (A3). Doing so provides:

$$\Pi \frac{\mathrm{d}\Pi}{\Pi} = \sum_{i=1}^{n} p_i\, q_i \frac{dq_i}{q_i} + \sum_{i=1}^{n} p_i\, q_i \frac{dp_i}{p_i} - \sum_{j=1}^{m} w_j\, v_j \frac{dv_j}{v_j} - \sum_{j=1}^{m} w_j\, v_j \frac{dw_j}{w_j}. \qquad \text{(A4)}$$

Next, divide all terms in expression (A4) by R or, equivalently, by $\Pi + \mathrm{C}$. Doing so and rearranging terms provides:

$$\sum_{i=1}^{n} r_i\, \dot{p}_i = \frac{C}{C+\Pi}\left[\sum_{j=1}^{m} s_j\, \dot{w}_j - \sum_{i=1}^{n} r_i\, \dot{q}_i + \sum_{j=1}^{m} s_j\, \dot{v}_j + \frac{\Pi}{C}\, \dot{\Pi} - \frac{\Pi}{C} \sum_{i=1}^{n} r_i\, \dot{q}_i \right], \qquad \text{(A5)}$$

where $r_i \equiv \frac{p_i\, q_i}{R}$ = the share of total revenue derived from the sale of the i^{th} service;

$s_j \equiv \frac{w_j\, v_j}{C}$ = the share of total cost accounted for by the j^{th} input; and

$\dot{x} \equiv \frac{dx}{x}$ = the rate of change of variable x (for $x = p_i, q_i, w_j,$ and v_j).

Let $\dot{P} = \sum_{i=1}^{n} r_i\, \dot{p}_i$, $\dot{W} = \sum_{j=1}^{m} s_j\, \dot{w}_j$, $\dot{Q} = \sum_{i=1}^{n} r_i\, \dot{q}_i$, and $\dot{V} = \sum_{j=1}^{m} s_j\, v_j$. Then expression (A5) can be written as:

$$\dot{P} = \frac{C}{C+\Pi}\left[\dot{W} - \left(\dot{Q} - \dot{V}\right) + \frac{\Pi}{C}\left(\dot{\Pi} - \dot{Q}\right) \right]. \qquad \text{(A6)}$$

$\dot{Q} - \dot{V}$ is the regulated firm's TFP growth rate ($\dot{T}$), which is the difference between the growth rate of the firm's outputs and the growth rate of its inputs.[36] Because $\dot{T} = \dot{Q} - \dot{V}$, expression (A6) can be written as:

$$\dot{P} = \frac{C}{C+\Pi}\left[\dot{W} - \dot{T} + \frac{\Pi}{C}\left(\dot{\Pi} - \dot{Q}\right) \right]. \qquad \text{(A7)}$$

[36] Revenue shares (r_i) are employed to aggregate the growth rates of individual outputs. Cost shares (s_j) are employed to aggregate the growth rates of individual inputs.

Expression (A7) identifies the growth rate of the firm's output prices that will ensure a profit growth rate of $\dot{\Pi}$ when the firm's profit is Π, its costs are C, its input price growth rate is $\dot{W}$, its output growth rate is $\dot{Q}$, and its TFP growth rate is $\dot{T}$. In particular, if the firm earns a normal profit (so its economic profit, Π, is zero), then the firm's profit will not change (so $\dot{\Pi} = 0$) if the firm's prices increase at a rate equal to the difference between its input price growth rate and its TFP growth rate, *i.e.*, if:

$$\dot{P} \;=\; \dot{W} - \dot{T}. \tag{A8}$$

Observe that equation (A8) is identical to equation (1).

Output price growth rates in sectors other than the regulated sector can be linked to profit levels, productivity growth rates, etc. exactly as they are so linked in expression (A7) for the regulated industry. This linkage is summarized in expression (A9), where the superscript "E" on a variable denotes the value of that variable elsewhere in the economy (*i.e.*, outside of the regulated industry).

$$\dot{P}^E = \frac{C^E}{C^E+\Pi^E}\left[\dot{W}^E - \dot{T}^E + \frac{\Pi^E}{C^E}\left(\dot{\Pi}^E - \dot{Q}^E\right)\right]. \tag{A9}$$

Subtracting expression (A9) from expression (A8) and rearranging terms provides:

$$\begin{aligned}\dot{P} \;=\; \dot{P}^E &- \left[\left(\frac{C}{C+\Pi}\right)\dot{T} - \left(\frac{C^E}{C^E+\Pi^E}\right)\dot{T}^E\right] - \left[\left(\frac{C^E}{C^E+\Pi^E}\right)\dot{W}^E - \left(\frac{C}{C+\Pi}\right)\dot{W}\right] \\ &- \left[\left(\frac{\Pi^E}{C^E+\Pi^E}\right)\dot{\Pi}^E - \left(\frac{\Pi}{C+\Pi}\right)\dot{\Pi}\right] - \left[\left(\frac{\Pi}{C+\Pi}\right)\dot{Q} - \left(\frac{\Pi^E}{C^E+\Pi^E}\right)\dot{Q}^E\right].\end{aligned} \tag{A10}$$

Now define the X-factor as:

$$\begin{aligned}X \;=\; &\left[\left(\frac{C}{C+\Pi}\right)\dot{T} - \left(\frac{C^E}{C^E+\Pi^E}\right)\dot{T}^E\right] + \left[\left(\frac{C^E}{C^E+\Pi^E}\right)\dot{W}^E - \left(\frac{C}{C+\Pi}\right)\dot{W}\right] \\ &+ \left[\left(\frac{\Pi^E}{C^E+\Pi^E}\right)\dot{\Pi}^E - \left(\frac{\Pi}{C+\Pi}\right)\dot{\Pi}\right] + \left[\left(\frac{\Pi}{C+\Pi}\right)\dot{Q} - \left(\frac{\Pi^E}{C^E+\Pi^E}\right)\dot{Q}^E\right].\end{aligned} \tag{A11}$$

Combining expressions (A10) and (A11) provides:

$$\dot{P} \;=\; \dot{P}^E - X\,. \tag{A12}$$

Suppose (economic) profit is zero outside of the regulated industry, perhaps because of strong competitive pressures. Also suppose the regulator wishes to ensure zero (economic) profit in the regulated industry. Then expression (A11) implies that the relevant X-factor is:

$$X = \left(\dot{T} - \dot{T}^E\right) + \left(\dot{W}^E - \dot{W}\right). \quad \text{(A13)}$$

Consequently, expression (A12) can be written as:

$$\dot{P} = \dot{P}^E - X = \dot{P}^E - \left[\left(\dot{T} - \dot{T}^E\right) + \left(\dot{W}^E - \dot{W}\right)\right], \quad \text{(A14)}$$

which corresponds exactly to equations (3) and (4), and to equations (A1) and (A2) when $\dot{T} = \dot{T}^I$ and $\dot{W} = \dot{W}^I$. Employing industry productivity and input price growth rates rather than the corresponding rates of an individual regulated supplier can provide individual suppliers with added incentive to operate more efficiently than their counterparts.

Expression (A14) indicates that in order to limit industry suppliers to a normal profit, the regulator can first set prices in the regulated industry to secure a normal profit and then permit prices to rise, on average, at a rate equal to the economy-wide rate of output price inflation ($\dot{P}^E$) less an offset (X). The offset is the sum of: (i) the difference between the TFP growth rate in the regulated industry ($\dot{T}^I$) and the TFP growth rate in the rest of the economy ($\dot{T}^E$); and (ii) the difference between the input price growth rate in the rest of the economy ($\dot{W}^E$) and the input price growth rate in the regulated industry ($\dot{W}^I$).

Appendix B. The Commission's Estimates of Input Price Growth Rates

The purpose of this Appendix is to explain how the two methodologies employed by the Commission ("FCC Method 2" and "FCC Method 3") produce estimated CAGRs between – 1.84 percent and 0.60 percent for the prices of inputs employed to supply residential broadband and voice services using a fiber-to-the-premise network.[37]

Table B1 presents the findings from FCC Method 2. This method employs data from the CACM and other sources to derive low and high estimates of annual input price changes for ten cost categories. These estimates are weighted by the share of total cost accounted for by each of the ten cost categories. The resulting weighted annual input price changes are combined to provide a low estimate (– 1.16 percent) and a high estimate (0.43 percent) of the CAGR for input prices. As Table B1 reports, much of the difference in these estimates stems from variation in the rate at which the prices of electronic inputs change.

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[37] *BDS Order & FNPRM* ¶¶ 408-11; *id*. at Appendix C §§ II, III.

Cost category		% of total	Annual price change: Low estimate	Annual price change: High estimate	Weighted annual price change: Low	Weighted annual price change: High
		[1]	[2]	[3]	[4]	[5]
Labor	[a]	59.6%	2.47%	2.77%	1.47%	1.65%
Fiber	[b]	2.9%	-5.00%	-5.00%	-0.15%	-0.15%
Poles	[c]	1.2%	2.00%	2.00%	0.02%	0.02%
Conduit	[d]	2.2%	0.00%	0.00%	0.00%	0.00%
Drop	[e]	1.4%	-2.00%	-2.00%	-0.03%	-0.03%
ONT	[f]	9.1%	-5.00%	-5.00%	-0.46%	-0.46%
Fiber pedestals	[g]	2.7%	-5.00%	-5.00%	-0.14%	-0.14%
Splitters	[h]	5.7%	-5.00%	-5.00%	-0.29%	-0.29%
Electronics	[i]	6.4%	30.00%	10.00%	-1.92%	-0.64%
Land/Buildings	[j]	8.7%	3.56%	5.07%	0.31%	0.44%
Sum					**-1.16%**	**0.43%**

Table B1. Estimated Compound Annual Input Price Growth Rates: FCC Method 2.

Sources and Notes.

[1]: *BDS Order & FNPRM* at Appendix C, Table 2.

[2]-[3][a]: *BDS Order & FNPRM* at Appendix C, Table 3.

[2]-[3][b]-[i]: *Response to Professor Hogendorn*, Wireline Competition Bureau , FCC, at 11 (rel. July 25, 2013), https://apps.fcc.gov/edocs_public/attachmatch/DOC-322385A1.pdf ("*WCB Response to Hogendorn*").

[2]-[3][j]: *BDS Order & FNPRM* at Appendix C, Table 4

[4]: [1] x [2].

[5]: [1] x [3].

To consider the implications of the input price growth rates in Table B1 for an appropriate revision of the price cap index, suppose the CAGR of productivity in the supply of BDS between 2006 and 2016 were 3.4 percent, as estimated above. Then, if the corresponding CAGR of input prices were 0.43 percent, the price cap index would need to decline by 28.2 percent to limit the price cap LECs to a normal profit at the start of the new price cap regime.[38] The corresponding decline in the price cap index would be 40.2 percent if the corresponding CAGR of input prices were – 1.16 percent.[39]

To consider the implications of the input price growth rates in Table B1 for an appropriate X-factor, suppose the annual rate of productivity growth in the supply of BDS in the upcoming price cap period ($\dot{T}^I$) is expected to be 3.4 percent, the corresponding productivity growth rate in the U.S. economy ($\dot{T}^E$) is 1.2 percent, and the annual input price growth rate in the U.S. economy ($\dot{W}^E$) is 3.0 percent. Then from equation (3), the appropriate X-factor is 4.8 percent (= 3.4% – 1.2% + 3.0% – 0.4%) when $\dot{W}$ = 0.4 percent. The appropriate X-factor is 6.4 percent (= 3.4% – 1.2% + 3.0% + 1.2%) when $\dot{W}$ = – 1.2 percent.

Table B2 presents the findings from FCC Method 3. This method employs data from the CACM, from TDS Telecommunications Corporation, and from other sources to derive low and high estimates of annual input price changes for four cost categories. These estimates are weighted by the share of total cost accounted for by each of the four cost categories. The

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[38] If $\dot{T} = .034$ and $\dot{W} = .0043$, then $\dot{W} - \dot{T} = -.0297$. Therefore, equation (1) indicates that the price cap index should decline by 2.97 percent annually. This annual decline produces a 28.2 percent cumulative decline over an eleven-year period because ($1 - [1 - .0297]^{11} = 1 - 0.718 = .282$).

[39] If $\dot{T} = .034$ and $\dot{W} = -.0116$, then $\dot{W} - \dot{T} = -.0456$. Therefore, equation (1) indicates that the price cap index should decline by 4.56 percent annually. This annual decline produces a 40.2 percent cumulative decline over an eleven-year period because ($1 - [1 - .0456]^{11} = 1 - 0.598 = .402$).

resulting weighted annual input price changes are combined to provide a low estimate (– 1.84 percent) and a high estimate (0.60 percent) of the CAGR for input prices.

Cost category		% of total	Annual price change: Low estimate	Annual price change: High estimate	Weighted annual price change: Low	Weighted annual price change: High
		[1]	[2]	[3]	[4]	[5]
Labor	[a]	69.1%	2.47%	2.77%	1.71%	1.92%
Switching	[b]	3.8%	-3.79%	-3.79%	-0.14%	-0.14%
Transmission	[c]	20.1%	-18.22%	-7.64%	-3.66%	-1.54%
Land/Buildings	[d]	7.1%	3.56%	5.07%	0.25%	0.36%
Sum					**-1.84%**	**0.60%**

Table B2. Estimated Compound Annual Input Price Growth Rates: FCC Method 3.

Sources and Notes.

[1]: Attachment 1, of Letter from Steve Pitterle, TDS Telecommunications Corporation, to Marlene H. Dortch, Secretary, FCC, WC Docket No. 05-25 (filed Sept. 24, 2015).

[2]-[3][a]: *BDS Order & FNPRM* at Appendix C, Table 3.

[2]-[3][b]-[c]: *WCB Response to Hogendorn* at 11 (Average of price change estimates weighted by cost shares.).

[2]-[3][d]: *BDS Order & FNPRM* at Appendix C, Table 4.

[4]: [1] x [2].

[5]: [1] x [3].

The implications of the input price growth rates in Table B2 for an appropriate revision of the price cap index and for an appropriate X-factor are provided in the text of this Declaration.[40]

[40] *See supra* ¶¶ 29, 37-38.

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HONORS AND AWARDS:

2015	Distinguished Member Award Transportation and Public Utilities Group.
2015	Faculty Honoree, Anderson Scholars Program University of Florida.
2011 – 2014	Research Foundation Professorship, University of Florida.
2003	Distinguished Service Award, Public Utility Research Center University of Florida.
2000	Faculty Honoree, Anderson Scholars Program University of Florida.
1998	Professorial Excellence Program Award, University of Florida.
1997 – 2000	Research Foundation Professorship, University of Florida.
1992	Research Achievement Award, University of Florida.
1976	Inducted into the Phi Beta Kappa Society.

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Oxford Economic Papers
Oxford University Press
Princeton University Press
Quarterly Journal of Economics
Quarterly Review of Economics and Business
Rand Journal of Economics
Research Grants Council of Hong Kong
Research in Labor Economics
Review of Economic Studies
Review of Economics and Statistics
Review of Industrial Organization
Review of Network Economics
Sloan Foundation
Southern Economic Journal
Telecommunications Policy
Utilities Policy
World Bank Economic Review

SELECTED ADDITIONAL EXPERIENCE:

1997 – Present	Instructor in *The International Training Program on Utility Regulation and Strategy*, sponsored by The World Bank and the University of Florida's Public Utility Research Center.
2015 – Present	Advisor to Sprint Corporation on The Design of Regulatory Policy for Special Access Services.
2014 – 2015	Advisor and Expert Witness for Norfolk Southern Corporation on The Design of Regulatory Policy in the Railroad Industry.
2014 – 2015	Advisor and Expert Witness for DISH Network on The Design of Competition Policy in Broadband and Media Markets.
2014 – 2015	Advisor to EPCOR Utilities Incorporated on The Design of Performance Based Regulation in the Energy Sector.
2014	Advisor to COFETEL, Mexico's Telecommunications Regulator on Price Cap Regulation in Mexico's Telecommunications Industry.
2013 – 2014	Advisor and Expert Witness for the Alliance of Automobile Manufacturers On the Design of Legislation Affecting the Automobile Industry.
2013	Advisor to AT&T on The Design of Spectrum Auctions.
2013	Advisor to Telefonica on The Design of Price Cap Regulation in Peru.
2013	Advisor to the National Grid Service Company on The Design of Service Quality Standards in the Electricity Sector.
2011	Advisor to Leap Wireless International on Competition Policy in the Wireless Communications Industry.
2011	Advisor to Telstra Corporation, Ltd. on the Design of Access Pricing Policy in Australia's Telecommunications Industry.
2010	Advisor to COFETEL on Competition Policy in Mexico's Communications Industry.
2010	Advisor to the U.S. Federal Communications Commission on Incentive Regulation and Broadband Deployment.

SELECTED ADDITIONAL EXPERIENCE (CONTINUED):

2009	Advisor to the OECD on Competition Policy in Mexico's Communications Industry.
2009	Advisor to Afilias on the Design of Policy to Assign Internet Names and Addresses.
2008 – 2009	Advisor and Expert Witness for AT&T on the Design of Competition Policy in the U.S. Telecommunications Industry.
2008	Member of Advisory Committee to the "Electronic Health Information Exchange Project," sponsored by the National Governors Association.
2008	Advisor to United States Cellular Corporation on the Design of Telecommunications Universal Service Policy.
2007 – 2008	Advisor to United Parcel Service on the Design of Regulatory Policy in the Postal Industry.
2006 – 2007	Advisor to Earthlink, Inc. on the Design of Telecommunications and Internet Competition Policy.
2006 – 2007	Advisor to Telstra Corporation, Ltd. on the Design of Competition Policy in Australia's Telecommunications Industry.
2005 – 2006	Advisor to General Communication, Inc. on the Design of Telecommunications Competition Policy.
2005	Advisor to United Parcel Service on Competition Policy in the U.S. Postal Industry.
2004 – 2005	Advisor to the Antitrust Division of the U.S. Department of Justice on Competition Policy in the Telecommunications Industry.
2004	Advisor to OSIPTEL, Peru's Telecommunications Regulatory Agency, on the Design of Price Cap Regulation
2003 – 2004	Advisor to SBC, Inc. on the Design of Performance Measurement Systems in the U.S. Telecommunications Industry.
2003	Presented Invited Testimony to the President's Commission on the United States Postal Service.

SELECTED ADDITIONAL EXPERIENCE (CONTINUED):

2003	Advisor to General Communication, Inc. on the Design of Universal Service and Competition Policy.
2001	Advisor to CONATEL, Ecuador's Central Regulatory Body on the Design of Telecommunications Policy.
2000 – 2001	Advisor to Ameren UE on the Design of Incentive Regulation for Electric Utilities.
1999 – 2000	Advisor to the Antitrust Division of the U. S. Department of Justice on a Proposed Merger in the Communications Industry.
1998 – 2000	Consultant and Expert Witness for United Parcel Service on Postal Industry Pricing.
1998 – 2000	Advisor to the World Bank on Telecommunications Privatization in Africa.
1996	Consultant and Expert Witness for TELUS Communications, Inc. on the Design of Price Cap Regulation.
1995	Advisor and Expert Witness for GTE-California on Incentive Regulation and Telecommunications Competition Policy.
1992 – 1994	Advisor to the Southern Bell Telephone Company on the Design of Incentive Regulation.
1992	Advisor to the New York State Public Service Commission on Incentive Regulation in the Electric Power Industry.

REDACTED – FOR PUBLIC INSPECTION

ZARAKAS CV

William P. Zarakas is a Principal with The Brattle Group, an economics consulting firm, and an expert on economic and regulatory matters involving the communications and energy industries. He has worked on a wide range of issues concerning the telecommunications and media industries, including cost and pricing analyses in regulated industries, economic feasibility analyses associated with building-out broadband infrastructure, valuation of wireless spectrum, and, analyses rates and the distribution of royalties in the cable and satellite television industries.

Mr. Zarakas also has extensive experience in analyzing the economics and regulation of utility infrastructure and the evolving factors that are affecting utility business models. Recent applications of this focus include the impacts distributed generation resources on utility business models and cost-benefit analyses relating to utility investments in smart grids and system resiliency. Mr. Zarakas also works on matters pertaining to the regulatory frameworks, notably with respect to performance based regulation, and the valuations of utility assets and businesses. He has also examined the impacts of investment levels, operational performance, operating cost levels, and rates on utility equity prices and on customer satisfaction.

Mr. Zarakas has provided testimony and expert reports before the Federal Communications Commission, the Federal Energy Regulatory Commission, the Securities and Exchange Commission, the Copyright Royalty Judges (Library of Congress), the U.S. Congress, state regulatory agencies, arbitration panels, foreign governments and courts of law. He has led (and authored reports concerning) special investigations on behalf of corporate boards of directors and audits of management practices and operational and financial performance on behalf of regulatory commissions. He holds an M.A. in economics from New York University and a B.A., also in economics, from the State University of New York.

Communications Economics and Valuations

- Competition Modeling. Provided testimony concerning vertical foreclosure and Nash bargaining models in the Application of Comcast Corporation, General Electric Company and NBC Universal, Inc. for Comcast to Assign or Transfer Control of Licenses, Federal Communications Commission, MB Docket No. 10-56.
- Cost Modeling: Developed model that estimated the cost of deploying mobile broadband in rural areas, on behalf of GCI. Authored expert report and presented model and conclusions to the FCC In The Matter Of Connect America Fund and Universal Service Reform – Mobility Fund.
- Royalty Distribution: Analyzed costs and value of retransmitted television programming in cable and satellite video markets and determined distribution of copyright royalty fees among content providers. Authored expert report Before The Copyright Royalty Judges, Library of

Congress, Washington D.C. In The Matter of Distribution of the 2004 and 2005 Cable Royalty Funds, Docket No. 2007-3 CRB CD 2004-20. June 1, 2009

- Spectrum Valuation: Directed, authored reports, and/or provided expert testimony in cases involving valuations of wireless spectrum valuation. Cases involved determining market comparable values and performing discounted cash flow (DCF) and econometric-based analyses. Analyses were conducted on behalf of communications carriers, regulatory and governmental agencies in the U.S. and abroad, capital management companies, financial institutions and debtors.
    - Conducted analyses and authored expert report estimating value of Mobile Satellite Service (MSS) spectrum (i.e., the 2 GHz Band from 2000-2020 MHz and 2180-2200 MHz, the Big LEO from 1610-1626.5 MHz and 2483.5-2500 MHz, and the L-band from 1525-1559 MHz and 1626.5-1660.5 MHz) in several matters, including matters involving the Terrestar bankruptcy. Analyses included impact of incorporating FCC authorized ancillary terrestrial component (ATC) into MSS mobile broadband networks.
    - Analyzed spectrum values in the 2.3 and 2.5 GHz bands for the U.S. market.
    - Analyzed value of Advanced Wireless Services (AWS; 1.7 / 2.1 GHz) band for the U.S. market.
    - Analyzed value of unpaired 2.1 GHz spectrum for the U.S. market.
    - Analyzed value of 2.3 GHz (WCS) 3.5 GHz (FWA) spectrum in Canadian market.
    - Authored report concerning market comparable analysis of U.S. PCS market.
    - Provided expert testimony concerning potential value of wireless spectrum in the 700 MHz band.
    - Analyzed value of Specialized Mobile Radio (SMR) and Private Land Mobile Radio Services (PLMRS) spectrum on behalf of utility operating companies in the U.S. market.
    - Analyzed value of narrowband PCS and IVDS spectrum portfolio.
    - Directed, led analysis and authored report concerning valuations of wireless spectrum in the Middle East-North African (MENA) region for an international wireless operator.
    - Directed, led analysis and authored report concerning impact of additional wireless operators on spectrum values for the telecommunications regulator in the Kingdom of Jordan.

- Pole Attachments: Analyzed and provided testimony concerning the determination of the rates for pole attachments under the FCC's Cable Rate and Telecom Rate Formulas as applied to electric utility distribution assets. Virginia Cable Telecommunications Association v. Virginia Electric and Power, 2001.
- International Arbitration (satellite communications): Authored expert report concerning the impact of an alleged breach of contract on lost profits in a 23 country business operation concerning a satellite communications business. Performed detailed financial modeling to determine revenues, net income and net present value using risk adjusted discount rates for a satellite service provider.
- Commercial Litigation (broadband communications): Provided expert testimony concerning the estimate of commercial damages stemming from an alleged breach of contract associated with relocating infrastructure assets. Public Service Company of New Mexico vs. Smith Bagley, Inc. and Lite Wave Communications LLC In The United States District Court For The District of New Mexico. March 2007.
- Commercial Litigation (wireline communications): Developed analysis and supported expert testimony concerning damages associated with cable breaks and disruption of wholesale transport services. Analysis involved estimating lost profits and determining replacement cost of temporarily lost capacity. MCI WorldCom Network Services, Inc. v. MasTec, Inc. before the United States District Court Southern District of Florida, Case No. 01-2059-CIV-GOLD. May 2002.
- Asset Valuations: Directed and led multiple valuation analyses of telecommunications assets and businesses. Projects included valuations of infrastructure assets in multiple markets worldwide. Projects required comprehensive discounted cash flow and net present value analyses, as well as regression and statistical analyses of comparable market transactions. Projects resulted in valuations used in support of negotiations and/or in commercial litigation.

Rate, Cost, Pricing and Regulatory Analyses

- Performance Based Ratemaking Analyses. Conducted for utilities and regulators on matters concerning incentive regulatory frameworks as well as targeted performance incentives. Recent examples of authored expert reports and testimony: Massachusetts D.P.U. 12-120 and Hawaii Docket No. 2013-1041.

- Incentive Analysis for Electric Distribution Reliability. Comprehensive analysis of approaches to setting electric distribution reliability standards on behalf of the Australian Energy Market Commission (AEMC).
- Incentive Regulation. Comprehensive analysis of incentive systems to be applied to incumbent local exchange telephone carriers (ILECs) on behalf of the New York State Department of Public Service; involved modeling determining total factor productivity (TFP) based on empirical analysis and consideration of projected performance improvement initiatives.
- Electric Distribution Resiliency Analysis. Comprehensive benefit cost analysis employing value of lost load (VOLL) methodology conducted for Public Service Electric & Gas (PSE&G) in NJ BPU Docket No. EO13020155 and GO13020156.
- Cost and Rate Analyses:
    - Conducted for electric utilities concerning deployment of upgraded transmission and distribution infrastructure and smart grid applications.
    - Conducted on behalf of telecommunications and broadband companies in the United States, Europe and Asia concerning cost-of-service and incremental pricing principles for communications services products.
    - For a municipality deploying a Wi-Fi network by using street lights and utility infrastructure; analysis included determination of cost of service.
    - Expert Witness in multiple U.S. state regulatory proceedings concerning analysis of rates for unbundled network elements (UNEs), undertaken in fulfillment of requirements associated with the Telecommunications Act of 1996, using the Total Element Long Run Incremental Cost (TELRIC) methodology.
- Financial and Pricing Analyses: Conducted comprehensive financial analysis for a broadband communications provider in the U.S. market, including: developing projections of demand, price elasticities, revenue and capital and operating costs, and pricing points.
- Transfer Pricing: Performed comprehensive studies of affiliate transactions and cost allocations between holding companies and operating subsidiaries on behalf of telecommunications carriers and electric and gas utilities. Report filed before state regulatory commissions and the Federal Communications Commission.

- Performance Analysis: Analyzed wholesale access performance measurement systems on behalf of SBC (now AT&T). Project scope included analysis of the statistical validity of performance measures agreed upon by SBC and regulators as part of approval of SBC's provision of long distance services (as part of proceedings concerning Section 271 of the Telecommunications Act of 1996) or are the outcome of negotiations among various parties regarding proposed mergers. Work focused on detailed statistical testing of performance measures to determine whether measures reflected RBOC performance and supported regulatory goals of increased consumer welfare in local exchange markets.
- Regulatory Frameworks: Directed and led multiple engagements on behalf of telecommunications carriers, utilities and regulatory commissions concerning the analysis of changes in regulatory frameworks, including: theoretical and quantitative analysis of the impact of adoption of earnings-based and price-based incentive rate plans upon retail prices and service quality; and a study of the impact of alternative regulatory frameworks on ILEC deployment of advanced telecommunications services, performed on behalf of a state regulatory commission.

Utility Strategic and Management Analysis

- Investment Analysis: Authored expert report concerning the impact investments in electric and gas utility infrastructure on system reliability and resiliency, especially following major weather events. Primary area of analysis involved estimation of economic value of investments to customers using value of lost load (VOLL) metrics for electric system investments and consumer surplus and value added metrics for gas system investment.
- Strategic Option Analysis: Directed Strategic Organizational Analysis for the Long Island Power Authority. Project involved definition and analysis of organizational options (privatization, municipalization and outsourced management services arrangements) available to LIPA going forward. Options were evaluated based on rate impacts and risk factors, including risks associated with organizational transformation. Project required extensive modeling of LIPA operations and financing scenarios, as well as analysis of power and transmission markets. Project work also involved interaction with LIPA's management team, its Board of Trustees and Board sub-committees.
- Merger Analysis: Authored expert reports concerning prospective merger savings and divestiture losses for electric and gas utilities. Scope of work included analyses involved in determining the operating and capital impacts of mergers under multiple scenarios, and also

involved the anticipated economic inefficiencies resulting from forced divestiture. Reports authored included studies of merger efficiencies and reports concerning Economic Loss Studies included in U-1 filings before the U.S. Securities and Exchange Commission. Economic Loss Studies are required under PUHCA Section 11 (b) (1) Clauses A, B, and C when utility merger results in the establishment of a registered holding company with electric and gas businesses. Work in these areas included detailed analyses of current and hypothetical future electric and gas utility operations.

- Benchmarking Analysis: Conducted transmission and distribution (T&D) function benchmarking study for a major Midwestern U.S. electric utility. Study involved comprehensive analysis of capital and operating costs and reliability and the impact that changes in expenditure would likely have upon earnings and shareholder value as well as distribution system reliability.
- Valuation: Directed and advised board of directors of a major generation and transmission (G&T) cooperative and its member electric distribution cooperatives on matters concerning: asset valuations, risk management strategy, merger and acquisition options, and outlook for retail electric markets.
- Feasibility Analyses: Conducted financial analyses and economic feasibility studies of new business opportunities for electric and gas utilities (e.g., fuel cell and distributed generation technologies and alternative fuel transportation) on behalf on numerous clients.
- Transfer Pricing: Authored reports and provided expert testimony on matters of affiliate transfer pricing, corporate overhead allocation, cost allocation, and cross-subsidization, performed on behalf of electric utilities and regulatory commissions. Also, analyzed business separation and affiliate safeguards regarding flow of information, systems access, marketing controls, employee and intellectual transfers and cost allocations for U.S. utilities.
- Rate Analysis: Conducted analyses of major utility capital investment, demand and consumption and cost-of-service performed on behalf of multiple electric and gas utilities and applied in utility rate cases before state and federal regulatory commissions
- Valuation: Performed asset valuation project on generation, transmission and distribution assets for a U.S. municipal electric utility. Determined original, trended original and replacement costs, as well as development of depreciation costs. Analyses used in developing electric rates and in proceeding on municipal special franchise taxes.

- Shareholder Value Analysis: For an east coast electric utility, analyzed impact on stock prices of new and potential markets (for core and non-core utility services), pricing strategies, underlying costs, and regulatory options.
- Margin Analysis: Conducted revenue and margin, geographic impacts and value analysis of utility energy efficiency initiatives on behalf of a major west coast electric utility.

Forensic Analysis and Special Investigations

- Forensic Analysis and Special Investigation: Directed consulting team and authored report for the forensic analysis of the economics, financial reporting and accounting associated with allegation of accounting and financial improprieties by Global Crossing. Worked on behalf of the Special Committee on Accounting Matters composed of a subset of (and reporting to) the Board of Directors of Global Crossing Ltd. Analysis involved determination of basis for revenue recognition for concurrent (i.e., "swap") transactions. Analysis included in report by the Special Committee entitled "The Concurrent Exchange of Fiber Optic Capacity and Services Between Global Crossing and its Carrier Customers." January 2003.
- Commercial Litigation: Directed expert consulting team in litigation matter concerning the deployment schedule of bandwidth on a major undersea cable project. Case involved allegations of breach of contract. Case work involved modeling of undersea fiber optic bandwidth in major undersea crossings and financial analysis of project viability.
- Forensic Analysis and Securities Litigation: Directed consulting team and led technical analysis concerning accounting and financial disclosure on behalf of the defendant in a class action against corporate officers, directors, controlling shareholders and the company's outside auditors alleging violations of the Securities Act of 1993 and the Securities Exchange Act of 1934. Scope of case involved accounting and disclosure treatment of complex leases.
- Special Investigations and Audits: Directed project teams, led technical analysis and authored reports in multiple special investigations and audits of management, operations and finance and accounting on behalf of regulatory utility commissions. Special investigations and audits involved allegations of improper cross subsidization and/or transfer pricing practices by regulated utilities (telecommunications, electric and/or natural gas) and their effect on rates charged to consumers. Special investigations and audits were conducted for regulatory commissions in Alabama, Kentucky, Maryland, New York and Pennsylvania.

Financial and Business Analyses

- Commercial Litigation: Developed expert report concerning damages associated with alleged breach of contract concerning gaming licenses in Asian casino markets. Analysis involved estimating projected cash flows under current and "but-for" scenarios.
- Economic Impact Analysis: Directed analysis and authored report regarding the effects of changes in regulatory fees and taxes on mobile prices, penetration and the macro economies of 22 countries in the Middle East and Africa. Study, conducted on behalf of a major mobile operator, involved detailed analysis of the relationships between marginal cost and prices, market structure and concentration, and empirical relationships concerning mobile penetration and GDP.
- Demand Analysis: Directed analysis and modeling of multiple projects involving the estimation and projection of segmented customer demand.
    - Analyzed U.S. subscriber market for video services.
    - Analyzed subscriber demand for communications services in the United States, Europe, Asia and the Middle East.
    - Led comprehensive analysis of current and projected market shares and competition in the consumer and business markets for network devices. Scope of work included geographic and customer segmentation; modeling included estimation of revenue and margins by segment.
- Consumer Welfare Analysis: Directed multiple analyses of impact of changes in market structure upon consumers.
    - Performed empirical analysis on panel of approximately 50 countries to demonstrate the effect of changes in levels of competition on prices, investment and other areas of consumer welfare for the global mobile telecommunication industry.
    - Directed analysis and authored white paper on empirical analysis concerning the impact of changing the price of wholesale access and levels of investment in the U.S. telecommunications market. Results reported in white paper entitled: "Structural Simulation of Facility Sharing: Unbundling Policies and Investment Strategy in Local Exchange Markets."
- Business Case Analysis: Directed and led multiple projects concerning the financial feasibility of entering new lines of business.

- Led feasibility study concerning development of publishing business for a major communications company. Work required comprehensive financial modeling.
- Performed comprehensive financial analysis for an infrastructure support company. Scope of work included market and competitive analyses, projections of market shares, cash flow modeling and pricing analysis.
- Performed comprehensive business case analysis of entry into the broadband market (including voice, internet access and video services) on behalf of a major U.S. electric utility. Scope of work included technology assessment and detailed financial modeling. Work included customer and geographic segmentation, pricing scenarios and elasticity analysis.
- Led comprehensive financial analysis concerning the deployment of a broadband communications network for an Asian electric utility. Related work included assessing transfer pricing methodologies regarding the use of utility assets, resources and easements by the broadband affiliate.
- Directed and led analysis of business diversification for multiple electric utilities. Business opportunities analyzed included dark fiber construction and third party use of utility poles, towers and conduit. Scope of analysis included financial modeling and transfer pricing.

TESTIMONY

Declaration of William P. Zarakas Before the Federal Communications Commission in the matter of Verizon Virginia. LLC and Verizon South, Inc., Complainants, v. Virginia Electric and Power Company d/b/a Dominion Virginia Power, Docket No. 15-90, File No. EB-15-MD-006 (November 18, 2015).

Declaration of William P. Zarakas and Matthew Aharonian (May 22, 2015) in the United States Court for the District of Columbia Circuit United States Telecom Association, Petitioner, v. Federal Communications Commission and the United States of America, Respondents, Case No. 15-1063 (and consolidated cases).

Analysis of the FCC's Vertical Foreclosure and Nash Bargaining Models Applied To The Proposed Comcast-Time Warner Cable Transaction (December 21, 2014) and Supplemental Declaration: Analysis of the FCC's Vertical Foreclosure and Nash Bargaining Models Applied To The Proposed Comcast-Time Warner Cable Transaction (March 5, 2015) in Application of Comcast Corporation, General Electric Company and NBC Universal, Inc. for Comcast to Assign or Transfer Control of Licenses, Federal Communications Commission, MB Docket No. 10-56.

Before the Public Utilities Commission of the State of Hawaii, In The Matter of Public Utilities Commission Instituting an Investigation to Reexamine the Existing Decoupling Mechanisms for Hawaiian Electric Company, Inc., Hawaii Electric Light Company, Inc., and Maui Electric Company, Limited, Docket No. 2013-1041, On Behalf of the Hawaiian Electric Companies. Report: "Targeted Performance Incentives: Recommendations to the Hawaiian Electric Companies," Prepared For The Hawaiian Electric Companies, William P. Zarakas and Philip Q Hanser, September 15, 2014.

Before the New Mexico Public Regulatory Commission, In The Matter Of The Application of TECO Energy, Inc., New Mexico Gas Company, Inc. and Continental Energy Systems, LLC, For Approval of TECO Energy Inc.'s Acquisition of New Mexico Gas Intermediate, Inc. and For All Other Approvals and Authorizations Required To Consummate and Implement The Acquisition, Utility Case No. 13-00231-UT, On Behalf of TECO Energy, Inc., New Mexico Gas Company, Inc. and Continental Energy Systems, LLC, Joint Applicants. March 2014.

"Analysis of Benefits: PSE&G's Energy Strong Program," by Peter Fox-Penner and William P. Zarakas. In the Matter of the Petition of Public Service Electric and Gas Company for Approval of the Energy Strong Program, NJ BPU Docket No. EO13020155 and GO13020156.

"Review and Analysis of Service Quality Plan Structure In The Massachusetts Department of Public Utilities Investigation Regarding Service Quality Guidelines For Electric Distribution Companies and Local Gas Distribution Companies." Philip Q Hanser, David E. M. Sappington and William P. Zarakas, Massachusetts D.P.U. 12-120, March 2013.

"Alaska Mobile Broadband Cost Model, Before The Federal Communications Commission In The Matter Of Connect America Fund and Universal Service Reform – Mobility Fund. WC Docket No. 10-90 and WT Docket No. 10-208A." William P. Zarakas and Giulia McHenry, February 2013

Expert Report of William P. Zarakas In The United States District Court For The Northern District of Florida MCI Communications Services, Inc., Plaintiff v. Murphree Bridge Corporation, Defendant, Case No. 5:09-cv-337, February 19, 2010.

Testimony of William P. Zarakas Before The Copyright Royalty Judges, Library of Congress, Washington D.C. In The Matter of Distribution of the 2004 and 2005 Cable Royalty Funds, Docket No. 2007-3 CRB CD 2004-20. June 1, 2009.

Declaration of William P. Zarakas In The Circuit Court of Fairfax County, Virginia In The Matter of Sharon Dougherty, Plaintiff Vs. Thomas J. Dougherty, Defendant Case No. CL 2007-008757. October 2008.

Expert report provided in Public Service Company of New Mexico vs. Smith Bagley, Inc. and Lite Wave Communications LLC In The United States District Court For The District of New Mexico. March 2007.

Expert report entitled "Comparative Market Value Analysis of Upper 700 MHz Public Safety Spectrum" in FCC WT Docket no. 96-86 (In the Matter of The Development of Operational, Technical and

Spectrum Requirements for Meeting Federal, State and Local Public Safety Communications Requirements Through the Year 2010). June 2006.

Expert report entitled "Analysis of Potential Lost Profits Associated With The Alleged Breach of Contract Between Orbcomm and Orbcomm Asia Limited" before the American Arbitration Association. May 2006.

Direct testimony before the Federal Communications Commission in the matter of *Petition of ACS of Anchorage, Inc. Pursuant to Section 10 of the Communications Act of 1934, as amended, for Forbearance from Sections 251(c)(3) and 251(d)(1) In the Anchorage LEC Study Area*, WC Docket No. 05-281, January 9, 2006.

Expert report co-authored with Dorothy Robyn Before the U.S. House of Representatives Committee on Energy and Commerce and the U.S. Senate Committee on Commerce, Science and Transportation regarding the value of wireless spectrum in the 700 MHz band. Letters, May 18, 2005.

Direct and rebuttal testimony before the Federal Communications Commission in the matter of *Virginia Cable Telecommunications Association v. Virginia Electric and Power Company, d/b/a Dominion Virginia Power and Dominion North Carolina Power*, PA No. 01-005, December 21, 2001.

Expert report Before the U.S. Securities and Exchange Commission included in Form U-1 Application/ Declaration Under The Public Utility Holding Company Act of 1935 in the combination of Energy East Corporation with RGS Energy Group, Inc. (June 20, 2001) in Exhibit J-1, entitled "Analysis Of The Economic Impact Of A Divestiture Of The Gas Operations Of Rochester Gas And Electric Corporation," May 15, 2001.

Expert report Before the U.S. Securities and Exchange Commission included in Form U-1 Application/ Declaration Under The Public Utility Holding Company Act of 1935 in the acquisition by Sierra Pacific Resources of Portland General Electric Company, 2000 in Exhibit H-1, entitled "Analysis Of The Economic Impact Of A Divestiture Of The Gas Operations Of Sierra Pacific Resources," January 31, 2000.

Before the U.S. Securities and Exchange Commission included in Form U-1 Application/ Declaration Under The Public Utility Holding Company Act of 1935 in the combination of Energy East Corporation with CMP Group, Inc. and with CTG Resources, Inc. in Exhibit J-1, entitled "Analysis Of The Economic Impact Of A Divestiture Of The Gas Operations Of Energy East," October 29, 1999.

Before the Supreme Court of the State of New York, County of Niagara, Supplemental Affidavit in *Village of Bergen, et al. vs. Power Authority of the State of New York*, February 1999.

Rebuttal Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the North Carolina Utilities Commission, Docket No. P-100, SUB 133D, Filed March 9, 1998; *In Re: Proceeding to Determine Permanent Pricing for Unbundled Network Elements*.

Direct Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the North Carolina Utilities Commission, Docket No. P-100, SUB 133D, Filed December 15, 1997; *In Re: Proceeding to Determine Permanent Pricing for Unbundled Network Elements*.

Rebuttal Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the South Carolina Public Service Commission, Docket No. 97-374-C, Filed November 25, 1997; *In Re: Proceeding to Review BellSouth Telecommunications, Inc.'s Cost Studies for Unbundled Network Elements*.

Direct Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Florida Public Service Commission, Docket Nos. 960757-TP/960833-TP/960846-TP/960916-TP/971140-TP, Filed November 13, 1997; *In Re: Petition of AT&T, MCI, and MFS for Arbitration with BellSouth Concerning Interconnection, Rates, Terms and Conditions of a Proposed Agreement*.

Direct Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the South Carolina Public Service Commission, Docket No. 97-374-C, Filed November 3, 1997; *In Re: Proceeding to Review BellSouth Telecommunications, Inc.'s Cost Studies for Unbundled Network Elements*.

Rebuttal Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Tennessee Regulatory Authority, Docket No. 97-01262, Filed October 17, 1997; *In Re: Contested Cost Proceeding to Establish Final Cost Based Rates for Interconnection and Unbundled Network Elements*.

Direct Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Tennessee Regulatory Authority, Docket No. 97-01262, Filed October 10, 1997; *In Re: Contested Cost Proceeding to Establish Final Cost Based Rates for Interconnection and Unbundled Network Elements*.

Rebuttal Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Alabama Public Service Commission, Docket No. 26029, Filed September 12, 1997; *In Re: Generic Proceeding: Consideration of TELRIC Studies*.

Rebuttal Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Georgia Public Service Commission, Docket No. 7061-U, Filed September 8, 1997; *In Re: Review of Cost Studies, Methodologies and Cost-Based Rates for Interconnection and Unbundling of BellSouth Telecommunications Services*.

Rebuttal Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Louisiana Public Service Commission, Docket Nos. U-22022/22093, Filed September 5, 1997; *In Re: Review of Consideration of BellSouth Telecommunications, Inc.'s TSLRIC and LRIC Cost Studies to Determine Cost of Interconnection Services and Unbundled Network Components, to Establish Reasonable, Non-Discriminatory, Cost-Based Tariff Rates*.

Direct Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Alabama Public Service Commission, Docket No. 26029, Filed August 29, 1997; *In Re: Generic Proceeding: Consideration of TELRIC Studies*.

Direct Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Louisiana Public Service Commission, Docket Nos. U-22022/22093, Filed July 11, 1997; *In Re: Review of Consideration of BellSouth Telecommunications, Inc.'s TSLRIC and LRIC Cost Studies to Determine Cost of Interconnection Services and Unbundled Network Components, to Establish Reasonable, Non-Discriminatory, Cost-Based Tariff Rates*.

Direct Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Georgia Public Service Commission, Docket No. 7061-U, Filed April 30, 1997; *In Re: Review of Cost Studies, Methodologies and Cost-Based Rates for Interconnection and Unbundling of BellSouth Telecommunications Services*.

Direct and rebuttal testimony Before the Virginia State Corporation Commission on behalf of United Telephone - Southeast, Inc. and Centel Corporation, May 1994.

Direct and rebuttal testimony Before the Tennessee Public Service Commission on behalf of United Telephone - Southeast, Inc., Docket No. 93-04818, January 28, 1994.

Direct and rebuttal testimony Before the Florida Public Service Commission on behalf of Southern Bell Telephone & Telegraph Company, Docket No. 920260-TL, December 10, 1993.

Direct and rebuttal testimony Before the Tennessee Public Service Commission on behalf of South Central Bell, Docket Nos**.** 92-13527 and 93-00311, March 22 and March 29, 1993.

PAPERS AND PUBLICATIONS

"Electric Utility Services and Evolving Platforms in the Mid-Atlantic Region," by William Zarakas, presented at the Mid-Atlantic Conference of Regulatory Utilities Commissioners (MACRUC) 20th Annual Education Conference, Williamsburg, VA, June 23, 2015.

"Growth Prospects and Shifting Electric Utility Business Models: Retail, Wholesale and Telecom Markets," by William P. Zarakas, *The Electricity Journal*, Volume 28, Issue 5, June 2015.

"Do We Need a New Way to Regulate Electric Utilities?," by William P. Zarakas, presented at the Energy Bar Association 2015 Annual Meeting, Washington, DC, May 6, 2015.

"Investing In Electric Reliability and Resiliency," by William P. Zarakas, presented at the NARUC 2014 Summer Meeting - Joint Electricity and Critical Infrastructure Committees, Dallas, TX, July 15, 2014.

"Utility Investments in Resiliency: Balancing Benefits with Cost in an Uncertain Environment," by William P. Zarakas, Sanem Sergici, Heidi Bishop, Jake Zahniser-Word and Peter S. Fox-Penner, *The Electricity Journal,* Volume 27, Issue 5, June 2014.

"Infrastructure and Competition in the Electric Delivery System," by William P. Zarakas, *The Electricity Journal*, Volume 26, Issue 7, September 2013.

"Low Voltage Resiliency Insurance, Portable small-scale generators could keep vital services on line during a major power outages," by William Zarakas, Frank Graves, and Sanem Sergici, forthcoming *Public Utilities Fortnightly* September 2013.

"Finding the Balance Between Reliability and Cost: How Much Risk Should Consumers Bear?," by William P. Zarakas and Johannes P. Pfeifenberger, presented at the Western Conference of Public Service Commissioners, Santa Fe, NM, June 3, 2013

"The Utility of the Future: Distributed or Not?," by William P. Zarakas, presented at Advanced Energy 2013, New York, NY, April 30, 2013

"Rates, Reliability, and Region," by William P. Zarakas, Philip Q Hanser, and Kent Diep, *Public Utilities Fortnightly*, January 2013

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VERIFICATIONS

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct to the best of my knowledge and belief.

Executed on June 22, 2016

David Sappington

REDACTED – FOR PUBLIC INSPECTION

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct to the best of my knowledge and belief.

Executed on June 28, 2016

William P. Zarakas