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BEFORE THE TENNESSEE PUBLIC UTILITY COMMISSION
NASHVILLE, TENNESSEE

Petition of Piedmont Natural Gas Company, Inc. for Approval of an Adjustment to Rates, Charges, and Tariffs Applicable to Service in Tennessee	))))	DOCKET NO. 20-00086

PRE-FILED DIRECT TESTIMONY OF

CHRISTOPHER C. KLEIN, PH.D.

ON BEHALF OF THE TENNESSEE ATTORNEY GENERAL
CONSUMER ADVOCATE

November 30, 2020

BEFORE THE TENNESSEE PUBLIC UTILITY COMMISSION
NASHVILLE, TENNESSEE

November 30, 2020

DOCKET NO. 20-00086

PRE-FILED DIRECT TESTIMONY OF
DR. CHRISTOPHER C. KLEIN

Q1. Please state your name and your current position.

A1. My name is Christopher C. Klein. I recently retired from my position as Professor in the Economics and Finance Department at Middle Tennessee State University (MTSU) in Murfreesboro, Tennessee.

Q2. What is your educational background?

A2. I received a B. A. in Economics from the University of Alabama in 1976 and I received a Ph. D. in Economics from the University of North Carolina at Chapel Hill in 1980.

Q3. What is your professional experience involving regulated industries?

A3. I was employed as an Economist in the Antitrust Division of the Bureau of Economics at the Federal Trade Commission (FTC) in Washington, D.C., for six years starting in 1980. In 1986, I was hired as the first Economist for the Tennessee Public Service Commission (TPSC). Although my title changed over the years, I functioned as the Chief Economist for the TPSC and, after 1996, the Tennessee Regulatory Authority (TRA), now known as the Tennessee Public Utilities Commission (TPUC), until August of 2002, when I assumed my position with MTSU. I retired from MTSU in 2019.

Q4. What were your duties at the FTC?

A4. I performed economic analysis in antitrust investigations involving more than 20 industries and contributed to staff reports on mergers in the petroleum industry, competition in grocery retailing, and the economics of predatory, or "sham," litigation.

Q5. What was your primary responsibility at the TPSC?

A5. I was an expert witness for the staff of the TPSC in proceedings involving telecommunications, natural gas, electric, and water utilities, as well as motor carriers. I testified in 36 dockets before the TPSC on the issues of cost of capital, rate design, and competitive effects. I also filed testimony before the Federal Communications Commission (FCC).

Q6. How did your responsibilities change when the TRA supplanted the TPSC?

A6. I directed the Utility Rate Division and then the Economic Analysis Division. The TRA staff no longer testified in proceedings before the agency but provided analysis and advice to the TRA Directors. I was responsible for all such advice and analysis provided to the Directors by these Divisions, either individually or in concert with other TRA staff, in all proceedings that came before the agency for resolution. These proceedings included rate cases and tariff filings by public utilities, as well as those associated with the implementation of the federal Telecommunications Act of 1996.

Q7. Were you a member of any regulatory committees or boards while you worked for the TPSC and the TRA?

A7. Yes. I was a member of the National Association of Regulatory Utility Commissioners (NARUC) Staff Subcommittee on Gas. I was a member of, and Chaired, the Research Advisory Committee to the Board of Directors of the National Regulatory Research Institute (NRRI). I also served on the State Staff of the FCC's Federal-State Joint Board

in CC Docket No.80-286 (the "Separations" Joint Board) and as a Group Leader on the NARUC Staff Subcommittee on Accounts Multi-state Audit Team that produced the 1988 Report on Bell Communications Research.

Q8. What was your primary responsibility at MTSU?

A8. I taught classes in the general area of applied microeconomics, including Principles of Microeconomics, Intermediate Microeconomic Theory, Managerial Economics, Economics of Antitrust and Regulation, and Econometrics, as well as undertaking scholarly research, participating in various university committees, and serving on dissertation committees.

Q9. Have you taught at any other universities?

A9. While I was employed at the TRA, I taught classes for several years in the Economics of Regulation and in Antitrust Economics as an adjunct in the Economics Department at Vanderbilt University.

Q10. Are you a member of any professional organizations?

A10. I am a member of the American Economic Association, the Southern Economic Association, the Industrial Organization Society, and Alpha Pi Mu: the National Industrial Engineering Honor Society, as well as Beta Gamma Sigma: the International Honor Society for Collegiate Schools of Business.

Q11. Have you published articles in professional or academic journals and presented papers at professional meetings?

A11. More than 40 of my articles have appeared in professional or academic journals such as *Energy Economics*, *Utilities Policy*, *The Electricity Journal*, *The Journal of Applied*

Regulation and many others. I have made more than 80 presentations at professional meetings.

Q12. Have you testified before any other governmental bodies in Tennessee?

A12. Yes. I have testified before various committees of the Tennessee General Assembly on regulatory issues, especially issues involving competition in the telecommunications industry, as well as before the Tennessee Advisory Commission on Intergovernmental Relations and the Tennessee Regulatory Authority. A complete list is provided in my Vita beginning on page 8 of my Exhibit.

PURPOSE OF TESTIMONY

Q13. What is the purpose of your testimony?

A13. I will address the Cost of Capital for Piedmont Natural Gas Company (Piedmont) and recommend an allowed rate of return for ratemaking purposes. This includes issues regarding capital structure, cost of debt, and cost of equity. I will also address the effect that implementing an Annual Review Mechanism for Piedmont could have on the cost of equity.

Q14. Can you summarize your testimony pertaining to capital structure and cost of debt?

A14. Yes. I find the capital structure and cost of debt presented by Piedmont's witness Jack Sullivan for the end of the attrition year, December 30, 2021, to be reasonable. This capital structure is shown on page 2 of my Exhibit.

Q15. Can you summarize your testimony on cost of equity?

A15. I recommend a cost of equity of 9.30% based on the Discounted Cash Flow (DCF) and Capital Asset Pricing Model (CAPM) methods shown on pages 3 through 7 of my Exhibit. I recommend no additional adjustments for floatation costs. I further recommend that the TPUC establish in this docket an allowed return on equity for Piedmont to be applied in the event that an ARM is implemented. I recommend an allowed equity return for use with an ARM for Piedmont that is approximately 50 basis points less than the equity return adopted in this docket.

Q16. What overall cost of capital do you recommend for use as the allowed rate of return for Piedmont?

A16. I recommend an overall weighted cost of capital of 6.60% as shown on page 2 of my Exhibit.

Q17. How is your testimony organized?

A17. I will address the concept of cost of capital first, then capital structure and cost of debt. This is followed by cost of equity. Where appropriate, I will comment on the testimony of Piedmont's witnesses Jack Sullivan and Dylan W. D'Ascendis.

COST OF CAPITAL

Q18. What do you mean by cost of capital?

A18. I mean the rate of return necessary to induce investors to hold the debt and stock of a company. This rate of return should be equal to that available to investors on alternative investments of similar risk.

Q19. How is the cost of capital related to the legal principles of determining the allowed rate of return for regulated utilities?

A19. The cost of capital concept embodies the economic principles for determining the allowed rate of return set out by the U.S. Supreme Court in *Bluefield Waterworks & Improvement Co. v. P.S.C. of W. Va.*, 262 U.S. 679 (1973) and *Fed. Power Comm'n v. Hope Natural Gas Co.*, 320 U.S. 591 (1944). For instance, the Court stated in *Hope* that, "…the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks. That return, moreover, should be sufficient to assure confidence in the financial integrity of the enterprise, so as to maintain its credit and to attract capital." (320 U.S. at 603). In order to achieve the goals established by the Supreme Court, it is my opinion that the allowed rate of return on the capital employed by Piedmont should be set equal to its cost of capital.

Q20. What are the consequences of not setting the allowed rate of return equal to the cost of capital?

A20. If the allowed rate of return is set below the cost of capital, then the company's credit rating will fall and its cost of debt will rise. The price of its stock will decline to reflect the lower expected return. Eventually, the company may face difficulties in financing investments in new plant and equipment, causing the quality of its products and services to decline.

If the allowed rate of return is set above the cost of capital, then the price of the firm's stock rises to reflect the higher return and the firm's stockholders realize a capital gain. Moreover, the capital gain is paid for by the firm's customers in the form of excessively high prices.

Clearly, failure to set the allowed rate of return equal to the firm's cost of capital is detrimental to the firm's customers as well as its stockholders.

CAPITAL STRUCTURE AND COST OF DEBT

Q21. What was your first step in estimating the cost of capital for Piedmont?

A21. My first step was to determine the appropriate capital structure and cost of debt for Piedmont. I started with the capital structure proposed by Piedmont's witness Jack Sullivan. Mr. Sullivan recommends the forecasted capital structure of Piedmont as of December 31, 2021. Apparently, since the acquisition of Piedmont by Duke Energy, all of Piedmont's financing has been arranged through Duke Energy or its subsidiaries. I compared Mr. Sullivan's recommended capital structure to the historical capital structures of Piedmont and Duke Energy (Discovery Requests CA 1-54 and 1-55). The proportion of equity in Piedmont's forecasted structure is higher and the proportion of debt is lower than those indicated by the historical structures, but the trend has been toward higher equity proportions. This is consistent with Piedmont's goal of achieving an approximate 50% equity capital structure in 2021. I find no historical evidence to contradict the capital structure forecasted by Piedmont for the end of the attrition period. This structure is also similar to that adopted by the TPUC for Chattanooga Gas in its most recent rate case (18-00017).

Q22. Did you examine the cost rates on short term and long term debt recommended by Mr. Sullivan?

A22. Yes. I also compared the cost rates on debt proposed by Mr. Sullivan to the historical cost rates for Piedmont as well as those in the most recent rate case before the TPUC for Chattanooga Gas Company (18-00017). The cost rates proposed by Piedmont for the end of the attrition period compare favorably in both cases. Consequently, I find these cost rates to be reasonable.

Q23. What is your conclusion on Piedmont's capital structure and cost rates for short term and long term debt?

A23. I find no reason to oppose the capital structure and cost rates on debt proposed by Mr. Sullivan for Piedmont in this case. These are shown on page 2 of my Exhibit.

COST OF EQUITY

Q24. How do you estimate the cost of equity of Piedmont?

A24. I use the Discounted Cash Flow (DCF) and Capital Asset Pricing Model (CAPM) methods.

Q.25 Can you explain the Discounted Cash Flow method?

A25. Yes. The DCF method views investors as valuing a company's stock based on the present value of the cash flows a stockholder expects to receive from owning the stock over an infinite time horizon. These cash flows from stock ownership are just the dividends paid by the company. Consequently, some simple mathematics show that the rate of return an investor expects on stock ownership in a company is the dividend yield for the current period plus the expected growth rate in that dividend. The dividend yield is just the expected dividend divided by the current price of the stock.

Q26. Have you computed a DCF cost of equity for Piedmont?

A26. Yes. Page 3 of my Exhibit shows this calculation for the seven firms selected by Piedmont's witness, Dylan W. D'Ascendis, from those natural gas distribution companies covered by Value Line. I start with recent dividend yields and expected growth rates as reported by Value Line on August 28, 2020. Page 3 of my Exhibit shows these dividend yields as well as historical and forecasted growth rates in dividends and earnings for the seven firms.

I use the forecast or expected growth in dividends per share from Value Line for the growth rate in the DCF formula. The DCF cost of equity based on the average dividend yields and expected dividend growth rates for the seven firms on page 3 is 8.57%. Mr. D'Ascendis prefers expected earnings growth as a proxy for dividend growth. The DCF cost of equity using average expected earnings growth for the seven firms on page 3 is 13.21%.

Q27. Do you agree with the use of earnings growth as a proxy for dividend growth in the DCF model?

A27. No. I elaborate on this point below in my comments on Mr. D'Ascendis's analysis. Here, I point out that the reason for the high DCF cost of equity using expected earnings growth as a proxy for expected dividend growth is the double-digit expected earnings growth rates for two of the seven firms, Northwest Natural Gas and South Jersey Industries. These two firms are also the only two of the seven firms with negative historical earnings growth. It seems clear that the high rates of expected earnings growth are making up for past negative earnings growth rates. Neither is typical of a public utility.

Q28. Have you calculated DCF cost of equity estimates for the firms on page 3 that do not have atypical earnings growth?

A28. Yes. These are shown on page 4 of my Exhibit for the five firms without negative historical earnings growth. For the five firms, the average expected growth rates in dividends and earnings are equal at 6%. Consequently, the estimated DCF costs of equity based on the average dividend yield and expected growth rates are also the same at 9.36%. The DCF estimates based on the midpoints of these data are slightly lower at 9.1% using dividend growth and 8.85% using earnings growth.

Q29. Have you updated your DCF calculations using more recent dividend yields?

A29. Yes. These updated DCF calculations for my five preferred firms are shown on page 5 of my Exhibit. To take into account the possible stock market reaction to the presidential election on November 3, I collected dividend yields from the Wall Street Journal for the Friday before the election, October 30, and the week following the election. On Monday, November 9, stock prices generally rose on election news as well as an announcement concerning the availability of COVID-19 vaccines. The stock market reaction continued through the week. Page 5 of my Exhibit shows that average dividend yields for the five firms fell from 3.6% on October 30 to 3.3% on November 9 and then to 3.22% by November 13. The DCF cost of equity estimates based on averages also fell from over 9.6% to 9.22% during this period. DCF estimates based on midpoints fell within the range of 8.9% to 9.3%.

Q30. What do you conclude from the DCF analysis?

A30. The DCF cost of equity range using average expected dividend growth rates for my five preferred firms is 8.94% to 9.612% with a midpoint of 9.27%. Most of these DCF

estimates using average expected growth rates hover near 9.30%. As a check on these cost of equity estimates, I also employed the Capital Asset Pricing Model, or CAPM.

Q31. Can you explain the CAPM?

A31. Yes. In the CAPM, an investor's required return on an investment is based on the relative riskiness of the investment. That is, an investor must expect a higher return in order to invest in a riskier enterprise. The CAPM begins by estimating the risk premium required on a broad portfolio of common stocks relative to a risk-free asset. This risk premium is then adjusted for a particular stock's riskiness relative to the market – that is, a broad portfolio of stocks. This is done by using the stock's beta, which measures the riskiness of the stock relative to the market. The resulting CAPM cost of equity consists of the risk-free return plus beta times the market risk premium.

Q32. How do you estimate the risk premium?

A32. I adopt the risk premia calculated by Aswath Damodaran using annual returns on the S&P 500 stocks and the 10-year Treasury Bond for the period 1928-2019 of 6.43%. (http://pages.stern.nyu/~adamodar/New-Home-Page/datafile/histretSP.html) I also report results for the CAPM using Damodaran's risk premium for short term Treasury Bills. These are shown on pages 6 and 7 of my Exhibit.

Q33. How do you choose the risk-free instrument and the appropriate risk premium?

A33. Technically, the lowest risk is associated with short term Treasury bills, because the short time frame provides the least opportunity for default and little chance that the expected inflation rate will not be realized over the life of the investment. Nevertheless, these short term bills also embody short term returns that may not reflect all factors affecting the expected return on a stock for a multi-year period. If one chooses longer term bonds

as the "risk-free" instrument, however, then expected returns over multiple years may be better captured, but more risk is also introduced. This is the risk that the actual inflation rate over the life of the bond may differ from expectations. If this occurs, then the real, inflation adjusted, return on the bond also differs from expectations. This inflation risk in a longer term bond raises the necessary return above the risk-free rate. The analyst must then trade-off any bias introduced by higher risk in longer term instruments against capturing the factors affecting the risk-free return over a longer period.

Q34. How do you make this trade-off?

A34. Since current interest rates on Treasury bills (T-bills) are at historically very low levels, consideration for longer term bonds is appropriate. Further, the low level of interest rates generally also means that the choice of the risk free rate makes less difference to the overall CAPM cost of equity estimate than when rates are high. For these reasons, I report results using both one-year T-bills and ten-year T-bonds. The ten-year bond is the only longer term U.S. Treasury instrument for which returns are available for the entire 1928-2019 period.

Q35. How do you adjust these estimates for specific companies?

A35. The risk premium is adjusted using a stock's beta. I use betas reported by ValueLine for the seven gas companies proposed by Mr. D'Ascendis (page 6 of my Exhibit) as well as my five preferred gas companies (page 7). Most of these companies are less risky than the average stock, with betas ranging from 0.8 to 1.0. An average stock, or a broad portfolio of stocks representing the market, has a beta of 1.0. Pages 6 and 7 of my Exhibit show the resulting range of CAPM cost of equity estimates. CAPM cost of

equity estimates for Mr. D'Ascendis's seven firms range from 6.123% to 8.332%, while for my five preferred firms the range is 6.123% to 7.514%.

Q36. Are there other factors that can affect the CAPM cost of equity estimates?

A36. Yes. The pertinent factor at this time is the tendency for the risk premium to expand when interest rates and bond yields are low and shrink when interest rates and bond yields are high. Consequently, because short term interest rates are near zero, the CAPM cost of equity estimates may underestimate the current cost of equity. Also, there is some evidence that the CAPM underestimates the cost of equity for firms with betas less than one. On page 7 of my Exhibit, I have also calculated cost of equity estimates for my five preferred firms using the ECAPM formula espoused by Mr. D'Ascendis to correct for this underestimate for firms with betas less than one. The resulting cost of equity estimates range from 6.44% to 7.718%. Nevertheless, it is reasonable to expect that the cost of equity of relatively low-risk utilities is less than the cost of equity of the market portfolio – that is, the CAPM estimate for a beta of one – of 7.409% to 8.332%.

Q37. How do you get the CAPM cost of equity for a stock with a beta of one?

A37. This is the market average beta of 1 multiplied by the risk premium with the result added to the current yield on the Treasury security. For short-term T-bills, this is 8.18% + 0.152% = 8.332%, while for T-bonds it is 6.43% + 0.979% = 7.409%.

Q38. What do you conclude on the cost of equity for Piedmont?

A38. The maximum CAPM cost of equity estimate for my 5 preferred firms is 7.524% and the maximum ECAPM is 7.718%. This is likely a lower bound on the cost of equity due to the previously mentioned tendencies of the CAPM. The DCF cost of equity range using average expected dividend growth rates for my five preferred firms is 8.94% to 9.612%

with a midpoint of 9.27%. Looking only at the DCF estimates using average expected dividend growth rates and average dividend yields, the average is 9.386%. I conclude that a reasonable cost of equity for Piedmont is 9.30%.

COMMENTS ON TESTIMONY OF DYLAN W. D'ASCENDIS

Q39. How does your cost of equity of 9.30% compare to that recommended by Piedmont's witness Mr. D'Ascendis?

A39. Mr. D'Ascendis recommends a cost of equity for Piedmont of 10.3%.

Q40. Do you agree with Mr. D'Ascendis's choice of comparable firms?

A40. As starting point for analysis, yes, but this is almost by default. The number of independent investor owned gas distribution companies has been shrinking as electric utilities acquire them. We've seen this in Tennessee as AGL Resources, the parent of Chattanooga Gas Company, was acquired by the Southern Company and, of course, Piedmont was acquired by Duke Energy. There are few natural gas distribution utility firms left to choose from. As I have explained above, I believe better cost of equity estimates can be obtained by dropping firms with atypical earnings growth patterns from the sample, but I have no fundamental objection to Mr. D'Ascendis's selection methods.

Q41. Do you agree with Mr. Ascendis's DCF estimates of the cost of equity?

A41. No. I primarily disagree with his use of earnings growth rates to derive the *dividend* growth rate in the constant growth DCF model. His justification for this appears to be that analysts' forecasts of earnings growth affect stock prices more than dividends do. This is not surprising from an econometric or statistical standpoint, because earnings,

earnings forecasts, and stock prices display frequent variations over time, while dividends, by design, only change once per year. This means changes in dividends can only explain changes in stock prices around the date of the annual dividend announcement, while changes in earnings or earnings forecasts can explain stock price changes at any time. This does not show that earnings forecasts are better at forecasting dividends than dividend forecasts are. The DCF formula explicitly calls for a dividend growth rate and not an earnings growth rate.

Q42. Do you agree with Mr. D'Ascendis's CAPM estimates of the cost of equity?

A42. No. There are two problems with Mr. D'Ascendis's CAPM and ECAPM estimates. The most serious is his calculation of the risk premium by using DCF estimates for the current equity return. Since he uses the same DCF methods for the risk premium estimates as for his DCF analysis of his comparable firms, the two methods are not independent. Hence, his CAPM methods do not provide an independent check on his DCF estimates. Plus, his use of earnings growth rates instead of dividend growth rates may bias his calculations. The second problem is his use of the 30-year bond yield as the risk-free rate of return. While U.S. government bonds are generally recognized as suitable for the risk-free asset, short term government bills are preferred, because the chance that inflation and interest rates will diverge from investor expectations over the life of a short-term bill is virtually nil. The difference between stock or equity returns and a risk-free rate of return reflects *only* the added return required for the risk embodied in stocks over and above the return required to offset the time value of money. The longer the term of the bond, the more inflation risk is embodied in the bond yield and the more the bond yield diverges from a true risk-free rate. Longer term bonds, rather than bills, can be used to get a longer term

perspective on interest rates, but this raises a trade-off between long term outlook and inflation risk. Using a 30-year bond maximizes the riskiness in this trade-off and will tend to overstate the implied equity return.

Q43. Do you agree with Mr. D'Ascendis's bond yield plus risk premium methods?

A43. No. Here he calculates a risk premium using regulators' authorized equity returns for gas distribution companies compared to returns on 30-year government bonds. Again, there are two major problems. One is the use of the 30-year bond to compute the risk premium as in his CAPM. The second is that it essentially takes other states' regulated gas company equity returns as appropriate for Tennessee, without any adjustments for local conditions or company characteristics. As shown in his Chart 12, his calculated risk premium can deviate from the predicted regression line by a percentage point or more in either direction. Where Tennessee companies lie within this range is not specified.

Q44. Do you agree with Mr. Ascendis's Expected Earnings approach?

A44. No. This approach is unfamiliar to Tennessee regulators and has failed to be adopted by the FERC as Mr. D'Ascendis recognizes in his Appendix A, page 21-22. For these reasons, I do not recommend its adoption for Piedmont.

Q45. Do you agree with Mr. D'Ascendis's adjustment for floatation costs?

A45. No. The TPUC generally does not recognize such adjustments when new stock issues are not anticipated as stated most recently in the Chattanooga Gas case (*Amended Order*, Docket No.18-00017, January 15, 2019, p.66). Moreover, Piedmont as a subsidiary of Duke Energy does not issue stock to the public, making any adjustment for flotation costs unnecessary. See response to MFR 83 ("Piedmont does not have common stock.").

Further, the adjustment for floatation costs proposed by Mr. D'Ascendis is so small (4 basis points) as to have no material effect on the allowed equity return.

COMMENTS ON AN ANNUAL REVIEW MECHANISM

Q46. Are you aware that Piedmont's petition in this case asks the TPUC "to adopt such ratemaking methodologies with respect to its revised rates and tariffs in this docket as will allow Piedmont to seek implementation of an Annual Review Mechanism" (or ARM) under T.C.A. 65-5-103d6?

A46. Yes.

Q47. What is your understanding of how the ARM operates?

A47. A company with an ARM files an annual report reviewing any changes in its costs and revenues. The TPUC reviews this filing and sets rates going forward such that the company is expected to earn the allowed return on equity established in its most recent rate case.

Q48. If Piedmont asks the TPUC to establish an ARM for it in the near future, then would the target return on equity be that established in this rate case?

A48. That is my understanding.

Q49. Will the establishment of an ARM for Piedmont reduce its business risk in a way that reduces its cost of equity?

A49. I believe that it will. The ARM will adjust Piedmont's rates for changes in its costs and revenues annually so that it may expect to earn its allowed return on equity. In the absence of an ARM, rates will not respond to changes in costs and revenues and

Piedmont's earned returns on equity can vary, up or down, from year to year. The ARM acts to reduce this variability in a company's return on equity relative to what would be experienced in the absence of an ARM. Since risk associated with common equity is measured by the variability of a firm's equity return, anything that reduces this variability reduces risk. Firms with lower risk require lower returns on equity to attract capital.

Q50. How much will an ARM reduce Piedmont's risk and cost of equity?

A50. The degree of the risk reduction from an ARM is difficult to quantify with precision, but it is possible to estimate the effect of any given risk reduction on a firm's cost of equity.

Q51. How is the reduction in cost of equity estimated for any given reduction in risk?

A51. Using the Capital Asset Pricing Model (CAPM), the change in the cost of equity due to a reduction in risk can be expressed as

$$ROE_1 - ROE_2 = [\text{proportional risk reduction}](\beta_1 r_p)$$

where β_1 is the company's "beta" before the risk reduction, and r_p is the "risk premium," or the difference between the risk-free rate of return and the market return. The derivation of this expression is shown on page 9 of my Exhibit. Using the risk premia I use for the CAPM on page 7 of my Exhibit along with values for beta representative of comparable gas distribution companies and the market, I calculate values for the change in the CAPM cost of equity for various proportional reductions in risk. The results of these calculations are shown on page 8 of my Exhibit.

Q52. What do these calculations show?

A52. Page 8 of my Exhibit shows changes in the expected equity return for risk reductions of 5%, 10%, and 15% using risk premia of 8.18% and 6.43% and values of beta of 0.8, 0.9, and 1.0. The resulting range of cost of equity reductions over all of these combinations is

very wide, from 25 to over 100 basis points. For a 10% risk reduction, which does not seem unreasonable for implementation of an ARM, with a risk premium of 6.43% and beta of 0.80, the estimated reduction in the cost of equity is 51.44 basis points.

Q53. Do any assumptions underlie your analysis?

A53. Yes. The derivation of the change in the cost of equity using the CAPM assumes that the correlation between the firm's return and the market return does not change and that the standard deviation of the market return does not change.

Q54. Are these assumptions reasonable?

A54. Yes. Piedmont and its parent Duke Energy are too small relative to the entire stock market, or the market for all investments, for changes in their earnings to affect the variability of the market return. The correlation coefficient between Piedmont's return and the market return could increase, decrease, or stay the same as the standard deviation of the equity return decreases after decoupling. In any event, the change would be an order of magnitude less than the change in the standard deviation of Piedmont's return. That is, if Piedmont's equity risk (standard deviation in its equity return) falls by 10% under an ARM, then the change, if any, in the correlation coefficient would likely be zero to plus or minus 1%. In this context, the assumption of no change in the correlation coefficient is reasonable.

Q55. Since the ARM itself is not at issue in this docket, what do you recommend for the TPUC in regard to an ARM in this case?

A55. I recommend that the TPUC set a reduction in the allowed return on equity established in this docket to be used in the event that an ARM is implemented for Piedmont in the near future.

Q56. What magnitude of reduction in the allowed return on equity under an ARM do you recommend?

A56. This is difficult to specify in advance, but a 10% reduction in risk after the implementation of an ARM seems reasonable. The corresponding reduction in the allowed return on equity is approximately 50 basis points.

CONCLUSION

Q57. Can you summarize your recommendations for the cost of capital of Piedmont?

A57. Yes. I do not object to the capital structure proposed by Piedmont shown on page 2 of my Exhibit. I recommend a cost of equity of 9.30% resulting in an overall cost of capital of 6.60%. I also recommend that the TPUC adopt in this docket an allowed return on equity to be used if and when an ARM is implemented for Piedmont. I recommend a 50 basis point reduction in the allowed return on equity in the event of an ARM.

Q58. Does this conclude your testimony at this time?

A58. Yes.

IN THE TENNESSEE PUBLIC UTILITY COMMISSION
AT NASHVILLE, TENNESSEE

IN RE:	)	
	)	
PIEDMONT NATURAL GAS COMPANY, INC. PETITION FOR AN ADJUSTMENT OF RATES, CHARGES, AND TARIFFS APPLICABLE TO SERVICE IN TENNESSEE	)	**DOCKET NO. 20-00086**
	)	
	)	
	)	
	)	

AFFIDAVIT

I, Christopher C. Klein, on behalf of the Consumer Advocate Unit of the Attorney General's Office, hereby certify that the attached Direct Testimony represents my opinion in the above-referenced case and the opinion of the Consumer Advocate Unit.

CHRISTOPHER C. KLEIN, PH.D.

Sworn to and subscribed before me
this ____ day of _____, 2020. 11/24/2020

F8C888EABFB1
Signed on 2020/11/24 11:23:54 -6:00

NOTARY PUBLIC

TERRA ALLEN
Tennessee Notary Public
Online Notary Public
Hickman County, State Of Tennessee
My Commission Expires Sep 28, 2022
Notary Stamp 2020/11/24 10:23:54 PST F8C888EABFB1

My commission expires: _____

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ON BEHALF OF THE TENNESSEE ATTORNEY GENERAL CONSUMER ADVOCATE

November 30, 2020

Capital Structure and Cost of Capital

Piedmont Natural Gas Company
Capital Structure and Cost of Capital[1]

Component	%	Cost Rate	Wtd. Cost
Short Term Debt	4.00%	0.40%	0.02%
Long Term Debt	45.50%	4.14%	1.88%
Common Equity	50.50%	9.30%	4.70%
Total	100.00%		6.60%

[1] Exhibit JLS-1 to the DirectTestimony of Jack Sullivan.

D'Ascendis Comparable Firms
ValueLine 8/28/20

			Growth Rates			
			Dividends		Earnings	
	Div Yield	Beta	Past	Forecast	Past	Forecast
Atmos	2.4	0.8	6.5	7.5	9.5	7
New Jersey Resources	3.8	0.9	6.5	6	6	2
Northwest Natural	3.6	0.8	0.5	1	-17	24.5
One Gas	3	0.8	17	7.5	9.5	6.5
South Jersey Industries	5.1	1	6	3.5	-2.5	12.5
Southwest Gas	3.3	0.9	9.5	4	4.5	9
Spire	4.3	0.8	5.5	5	9.5	5.5
Average	**3.64**	0.857	7.357	**4.928**	2.78	**9.57**
Mid-point	3.75	0.9	8.75	4.25	-7.5	13.25
DCF Estimates						
Averages			11	**8.57**	6.428	**13.21**
Midpoints			12.5	8	-3.75	17

Comparable Firms DCF
ValueLine 8/28/20

			Growth Rates			
			Dividends		Earnings	
	Div Yield	Beta	Past	Forecast	Past	Forecast
Atmos	2.4	0.8	6.5	7.5	9.5	7
New Jersey Resources	3.8	0.9	6.5	6	6	2
One Gas	3	0.8	17	7.5	9.5	6.5
Southwest Gas	3.3	0.9	9.5	4	4.5	9
Spire	4.3	0.8	5.5	5	9.5	5.5
Average	**3.36**	0.84	9	**6**	7.8	**6**
Mid-point	3.35	0.85	11.25	5.75	7	5.5
DCF Estimates						
Averages			12.36	**9.36**	11.16	**9.36**
Midpoints			14.6	9.1	10.35	8.85

Comparable Firms
Updated Dividend Yields
Wall Street Journal (wsj.com)

	Dividend Growth Forecast	10/30/2020 Div Yield	11/9/2020 Div Yield	11/13/2020 Div Yield
Atmos	7.5	2.51	2.35	2.45
New Jersey Resources	6	4.56	3.99	3.65
One Gas	7.5	3.13	2.94	2.83
Southwest Gas	4	3.42	3.21	3.24
Spire	5	4.44	4.03	3.93
Average	6	3.612	3.304	3.22
Mid-point	5.75	3.535	3.19	3.19
DCF Estimates				
Averages		**9.612**	**9.304**	**9.22**
Midpoints		9.285	8.94	8.94

CAPM ROE Estimates
D'Ascendis Firms

		Risk Premium		Recent Peak Yields 9/9/2020	11/10/2020	CAPM	
	Beta	Bills	Bonds	Bills	Bonds	Bills	Bonds
Atmos	0.8	8.18	6.43	0.152	0.979	6.696	6.123
New Jersey Res.	0.9	8.18	6.43	0.152	0.979	7.514	6.766
Northwest Natural	0.8	8.18	6.43	0.152	0.979	6.696	6.123
One Gas	0.8	8.18	6.43	0.152	0.979	6.696	6.123
South Jersey Ind.	1	8.18	6.43	0.152	0.979	8.332	7.409
Southwest Gas	0.9	8.18	6.43	0.152	0.979	7.514	6.766
Spire	0.8	8.18	6.43	0.152	0.979	6.696	6.123
Average						7.16	6.49
Mid-point						7.51	6.65

Sources
Beta: ValueLine 8/28/20
Risk Premia: Damodaran http://pages.stern.nyu/~adamodar/New-Home-Page/datafile/histretSP.html
Yields: WSJ.com

CAPM & ECAPM Estimates
Klein Firms

		Risk Premium		Recent Peak Yields 9/9/2020	11/10/2020	CAPM	
	Beta	Bills	Bonds	Bills	Bonds	Bills	Bonds
Atmos	0.8	8.18	6.43	0.152	0.979	6.696	6.123
New Jersey Res.	0.9	8.18	6.43	0.152	0.979	7.514	6.766
One Gas	0.8	8.18	6.43	0.152	0.979	6.696	6.123
Southwest Gas	0.9	8.18	6.43	0.152	0.979	7.514	6.766
Spire	0.8	8.18	6.43	0.152	0.979	6.696	6.123
Average						7.02	6.38
Mid-point						7.105	6.33

		Risk Premium		Recent Peak Yields 9/9/2020	11/10/2020	ECAPM	
	Beta	Bills	Bonds	Bills	Bonds	Bills	Bonds
Atmos	0.8	8.18	6.43	0.152	0.979	7.105	6.44
New Jersey Res.	0.9	8.18	6.43	0.152	0.979	7.718	6.926
One Gas	0.8	8.18	6.43	0.152	0.979	7.105	6.44
Southwest Gas	0.9	8.18	6.43	0.152	0.979	7.718	6.926
Spire	0.8	8.18	6.43	0.152	0.979	7.105	6.44
Average						7.35	6.637
Mid-point						7.41	6.6856

Sources
Beta: ValueLine 8/28/20
Risk Premia: Damodaran http://pages.stern.nyu/~adamodar/New-Home-Page/datafile/histretSP.html
Yields: WSJ.com

Reduction in CAPM Cost of Equity for Various Reductions in Risk

5% Risk Reduction
(Proportional Change in Sigma = 0.05)

		Risk Premium	
		8.18	6.43
	1	0.409	0.3215
Beta	0.9	0.3681	0.28935
	0.8	0.3272	0.2572

10% Risk Reduction
(Proportional Change in Sigma = 0.10)

		Risk Premium	
		8.18	6.43
	1	0.818	0.643
Beta	0.9	0.7362	0.5787
	0.8	0.6544	0.5144

15% Risk Reduction
(Proportional Change in Sigma = 0.15)

		Risk Premium	
		8.18	6.43
	1	1.227	0.9645
Beta	0.9	1.1043	0.86805
	0.8	0.9816	0.7716

Change in Cost of Equity Due to Reduced Risk

From the Capital Asset Pricing Model, a firm's expected cost of equity is:

$$ROE = r_f - \beta r_p$$

where r_f is the risk-free return, r_p is the risk premium (the difference between the risk-free return and the stock market return), and β is the individual firm's beta. Beta can be written as

$$\beta = \rho_{jm}\sigma_j\sigma_m = \sigma_j (\rho_{jm}\sigma_m) \qquad \text{for any firm j}$$

where ρ_{jm} is the correlation coefficient between the firm's return on equity and the market return; σ_j is the standard deviation of the firm's return on equity; and σ_m is the standard deviation of the market return. A reduction in risk will reduce the standard deviation of the firm's return, σ_j. Assuming that ρ_{jm} and σ_m do not change, then the reduction in the firm's cost of equity as a result of a reduction in risk may be calculated as

$$ROE_1 - ROE_2 = [r_f - \beta_1 r_p] - [r_f - \beta_2 r_p] = [\beta_1 - \beta_2] r_p$$

where subscripts 1 and 2 indicate before and after implementation of an ARM, respectively. Some further algebraic manipulation and substitution of $\sigma_j (\rho_{jm}\sigma_m)$ for β, gives

$$ROE_1 - ROE_2 = [(\beta_1 - \beta_2)/ \beta_1](\beta_1 r_p) = [(\sigma_{j1} - \sigma_{j2})/\sigma_{j1}] (\beta_1 r_p)$$

Or in simpler terms

$$ROE_1 - ROE_2 = [\text{proportional reduction in risk}](\beta_1 r_p)$$

Given values for the proportional change in risk, β_1, and r_p, the change in the firm's CAPM cost of equity can be calculated.

VITA

CHRISTOPHER C. KLEIN

EDUCATION:

Ph. D. (Economics), University of North Carolina - Chapel Hill (1980)
B. A. (Economics), University of Alabama - Tuscaloosa (1976)

EXPERIENCE:

2002-2019	**Middle Tennessee State University** Professor of Economics, 2013-2019 Associate Professor of Economics, 2002-2013
2002-Present	**Consultant** Clients include: AGL Resources, Inc.; Reseller Coalition; Tennessee Advisory Commission on Intergovernmental Relations; Tennessee American Water Company, Inc.; Tennessee Attorney General, Consumer Advocate; Tennessee Department of Environment and Conservation; US LEC of Tennessee, Inc.; Verizon Wireless; West Virginia American Water Company, Inc.; Z-Tel Communications, Inc.
1996-2002	**Tennessee Regulatory Authority** Chief, Economic Analysis Division, 1997-2002 Chief, Utility Rate Division, 1996-97
1998-2001	**Vanderbilt University** Adjunct Associate Professor of Economics
1986-1996	**Tennessee Public Service Commission** Director, Utility Rate Division, 1994-96 Economist & Research Director, 1993-94 Commission Economist, 1986-1993
1990-1994	**Middle Tennessee State University** Adjunct Faculty, Department of Economics and Finance
1980-1986	**Federal Trade Commission** Economist, Bureau of Economics - Antitrust Division

PROFESSIONAL ACTIVITIES:

Editor, *Journal for Economic Educators*, 2007-2019.

Member 1994-96, State Staff, Federal-State Joint Board, Federal Communications Commission CC Docket No.80-286 ("Separations" Joint Board).

Chair 1993-95, member 1990-95, Research Advisory Committee to the Board of Directors of the National Regulatory Research Institute at Ohio State University.

Member 1990-95, Staff Subcommittee on Gas, National Association of Regulatory Utility Commissioners.

Group Leader: Economics, Contracts, and Non-affiliate Revenue; NARUC* Staff Subcommittee on Accounts Multi-state Audit Team, 1988 Report on Bell Communications Research.

Referee: *Applied Economics, Contemporary Economic Policy, Eastern Economic Journal, Land Economics, Journal for Economic Educators, Journal of Economic Education, Management and Decision Economics, Media Economics, Review of Industrial Organization, Social Science Quarterly, Southern Economic Journal*.

Memberships: American Economic Association (AEA, since 1981), Southern Economic Association (1982), Industrial Organization Society (1986).

HONORS:

Beta Gamma Sigma, International Honor Society for Collegiate Schools of Business, 2008

Top 30 Score, 2003-2004 Student Evaluation of Faculty Performance, Jones College of Business, Middle Tennessee State University.

Resolution of Recognition, National Regulatory Research Institute, 1995

Listed in various Who's Who publications, 1990-

Certificate of Commendation, Federal Trade Commission,1985

First in my class to complete the Ph. D., 1980

Alpha Pi Mu, National Industrial Engineering Honorary, 1973

GRANTS RECEIVED:

MTSU Jones College Summer Research Grant: 2004, 2005, 2007, 2012.

MTSU Faculty Research and Creative Activity Academic Year Grant: 2004-2005 (with Reuben Kyle)

MTSU Faculty Research and Creative Projects Committee Summer Salary Grant: 2006, 2009.

TEACHING

At MTSU

ECON 2420, Principles of Economics – Microeconomics

ECON 3520, Intermediate Microeconomic Theory

ECON 4400, Economics of Antitrust and Regulation

ECON 4570, Managerial Economics

ECON 4620/5620, Econometrics and Forecasting

ECON 4720, Economic Issues in the Music Industry

ECON 7121, Seminar in Applied Microeconomic Theory (Ph.D. Program)

ECON 7250, Methods of Outcome Assessment (Ph.D. Program)
Student Internships (ECON/FIN 4890, ECON/FIN 5890, ECON/FIN 6440)

At Vanderbilt University

ECON 252, Antitrust Economics
ECON 283, Economics of Regulation

MTSU Dissertation Committees

Matthew Booth, *Macrodynamic Effects of Efficiency Wages and Wage Discrimination Policies Modeled with Habit Formation in Consumption*, Ph. D. 2018.
Mohammed Aldaghir, Chair, *Class Scheduling and Student Performance in Economic Principles*, Ph. D. 2017
Mohammed Saeed, *Three Essays on Educational Attainment and Emploment*, Ph.D. 20017.
Muhammad Yadudu, *Three Essays on Payday Loan Finance*, Ph. D. 2017.
Shea W. Slonaker, Chair, *Three Essays on the Recorded Music Industry*, Ph. D. 2009.
Hua Liu, *U.S. Trade Deficit, Productivity Growth and Offshore Outsourcing*, Ph. D. 2006.
Jennifer Wilgus, *A Life-Cycle Approach to Human Capital Investment and Skill-Biased Technological Change*, Ph. D. 2005.
Anealia Sasser, *A Theoretical Examination of Title IV Financial Aid for Higher Education*, D.A. 2004.

Vanderbilt University Dissertation Committees:

Aster Adams, *The Impact of Deregulation and Competition on Efficiency, Financial Performance, and Shareholder Wealth of Electric Utilities in the United States*, Ph. D. 2009.
David B. Sapper, *Trial Selection and the Effects of Sentencing Reform in Criminal Antitrust Cases: A Theoretical and Empirical Analysis*, Ph. D. 2006.
T. Randolph Beard, *Bankruptcy, Safety Expenditure, and Safety Regulation in the Motor Carrier Industry*, Ph. D. 1988

PUBLICATIONS

"The Effects of Time Spent Online on Student Achievement in Principles of Microeconomics," with Mohammed Aldaghir, submitted to *Journal of Education for Business*, 2019.

"Connecting Cultural Gender Norms and National Prosperity," with Molly Howell, *Journal for Economic Educators*, 18(1): 33-38, 2018.

"Do Major Currency Trading Volumes Explain Bitcoin's Price," with Jordan Evans, *Journal for Economic Educators*, 18(1): 39-45, 2018.

"Do State Funded Merit Scholarships for Higher Education Improve High School Graduation Rates?" with Elizabeth A. Perry-Sizemore, *Journal of Education Finance*, 43(2): 152-168, 2017.

"Sequence of MBA Core Course Completion and Student Performance in an MBA Program," with E. Anthon Eff, *Journal for Economic Educators*, 17(2): 29-42, 2017.

"The Music Industry as a Vehicle for Economic Analysis," *Journal of Economic Education*, 46(4),403-411, 2015.

"Education Production Functions," *Encyclopedia of Educational Theory and Philosophy*, D. Phillips ed., Sage: Los Angeles, 2014.

"Econometrics as a Capstone Course in Economics," *Journal of Economic Education*, 2013.

"Identifying the Best Buys in U.S. Higher Education," with E. Anthon Eff and Reuben Kyle, *Research in Higher Education*, 2012.

"Chart Turnover and Sales in the Recorded Music Industry: 1990-2005," with Shea W. Slonaker, *Review of Industrial Organization*, 36:351-372, 2010.

"What Can We Learn from Education Production Studies?" with E. Anthon Eff, *Eastern Economic Journal*, 36:450-479, 2010.

"Public Transportation Ridership Levels," with Christopher R. Swimmer, *Journal for Economic Educators*, 10(1): 40-46, Summer 2010.

"Analysis of U.S. Foreign Aid Determinants for 2003," with Joshua M. Hill, *Journal for Economic Educators*, 9(1): 48-52, Summer 2009.

"Intra-district Public School Funding Equity and Performance in Nashville, Tennessee," *Journal of Education Finance*, Summer 2008.

"A Tale of Three Inputs: Cost and Production Duality with Time Utilization of Capital," *Applied Economics Research Bulletin*, 1(1) 2008.

"Telephone Penetration in Tennessee: Are Intrastate Universal Service Policies Effective?" with Aster R. Adams and David B. Sapper, *Journal of Applied Regulation*, 2, November 2004, pp,. 87-108.

"A Switching Regime Approach to Measuring the Effects of Technological Change in Ocean Shipping," with J.David Bass and Reuben Kyle, *Journal of Productivity Analysis*, 22:1-2, July-September,2004, pp. 29-49.

"The Financial Implications of Unbundling on Bell Company Profits: A Review of the Evidence," with T. Randolph Beard and George S. Ford, *CommLaw Conspectus: The Journal of Communications Law and Policy*, v. 12 n.1, Fall/Winter 2003.

"Bell Companies as Profitable Wholesale Firms: The Financial Implications of UNE-P," with T. Randolph Beard, *Phoenix Center Policy Paper No. 17*, November 2002, www.phoenix-center.org.

"Connecting Tennessee: Bridging the Digital Divide," with Rose M. Gregory, *NRRI Quarterly Bulletin*, vol. 21 no. 3, Spring 2001.

"Regulation vs. Deregulation: It's All in the Externalities," *Tennessee's Business*, Middle Tennessee State University, v. 11, n. 3 (November), 2001.

"The Role of Public Power in a Restructured Electric Power Industry," with David Sapper, *The Electricity Journal*, August/September 2001.

"Regulator Preferences and Utility Prices: Evidence from Natural Gas Distribution Utilities," with George Sweeney, *Energy Economics*, vol. 21, n. 1, 1999.

"Competition in Telecommunications: A Progress Report for Tennessee," *Tennessee's Business*, Middle Tennessee State University, Murfreesboro, TN; vol. 9, n. 1, 1999.

"Technological Change and the Production of Ocean Shipping Services," with Reuben Kyle, *Review of Industrial Organization*, December 1997.

"The Haunting of Universal Service: Open Markets, Efficient Funding and the Ghost of the Fair Rate of Return," *Proceedings of Tenth NARUC Biennial Regulatory Information Conference*, National Regulatory Research Institute, Columbus, OH, 1996.

"Productivity Growth in Telecommunications: The Case of Tennessee," *Proceedings of Tenth NARUC Biennial Regulatory Information Conference*, National Regulatory Research Institute, Columbus, OH, 1996.

"Capture vs. Compromise: Entry Regulation of Intrastate Trucking," with Reuben Kyle and Jennifer Wilgus, *Logistics and Transportation Review*, v. 32 n. 3, September 1996.

"Price Discrimination: What is 'Undue' for a U.S. Utility?" *Utilities Policy*, vol. 4 no. 4, October 1994.

"Single Service Price Variations and 'Subsidies' in the Pricing of Telecommunications Services," *Proceedings of Ninth NARUC Biennial Regulatory Information Conference*, National Regulatory Research Institute, Columbus, OH, 1994.

"What Is Undue Price Discrimination by a Regulated Utility?" *NRRI Quarterly Bulletin*, March 1994.

"A Comparison of Cost-Based Pricing Rules for Natural Gas Distribution Utilities," *Energy Economics*, July 1993.

"Negotiating a Transportation Rate Under Threat of Bypass: A Case Study," *Proceedings of the Eighth Biennial Regulatory Information Conference*, National Regulatory Research Institute, Columbus, OH, 1992.

"A Multinomial Logit Model of Intrastate Trucking Regulation in Tennessee," with Jennifer Jose and Reuben Kyle, *Papers and Proceedings of the Nineteenth Annual Meeting of the Midsouth Academy of Economics and Finance*, v. 16 ,1992.

"Ramsey Prices for Natural Gas Distribution Utilities," *Proceedings of the Seventh NARUC Biennial Regulatory Information Conference*, National Regulatory Research Institute, Columbus, OH, 1990.

"Intervention as Entry Deterrence: Evidence from Sham Litigation Cases," *Proceedings of the Seventh NARUC Biennial Regulatory Information Conference*, National Regulatory Research Institute, Columbus, OH, 1990.

Book Review, *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, Edited by Robert W. Crandall and Kenneth Flamm, Brookings 1989; *Review of Industrial Organization*, Fall 1990.

"Double Leverage and Strategic Financing Decisions," *NRRI Quarterly Bulletin*, v. 11, n. 3, September 1990.

"Predation in the Courts: Legal Versus Economic Analysis in Sham Litigation Cases," *International Review of Law & Economics*, June 1990.

"Rate Design for Natural Gas Utilities: A Comparison of Ramsey and Cost of Service Pricing," *NRRI Quarterly Bulletin*, December 1989.

"Dissecting Divestiture: A Telecommunications Book Review Article," *Review of Industrial Organization*, October 1989.

The Economics of Sham Litigation: Theory, Cases, and Policy, Bureau of Economics Staff Report, Federal Trade Commission, April 1989.

"New Agreements, Non-affiliate Revenues, and Economic Issues," with Mike Amato and Francis Fok, in *Report on Bell Communications Research*, National Association of Regulatory Utility Commissioners, 1988.

"Merger Incentives and Cost of Capital Regulation of Subsidiaries," *Midsouth Journal of Economics and Finance*, March 1988.

"Strategic Sham Litigation: Economic Incentives in the Context of the Case Law," *International Review of Law & Economics*, December 1986.

"Is There a Principle for Defining Industries? Comment," *Southern Economic Journal*, October 1985.

"A Note on Defining Geographic Markets," with Ed Rifkin and Noel Uri, *Regional Science and Urban Economics*, February 1985.

"Process Analysis, Capital Utilization, and the Existence of Dual Cost and Production Functions," FTC Bureau of Economics Working Paper No. 116, May 1984.

"A General Theory of Hedonic Pricing of Capital as a Factor of Production," FTC Bureau of Economics Working Paper No. 105, December 1983.

"The International Market for Crude Oil," with Fred Lipson and Harvey Blumenthal, in *Mergers in the Petroleum Industry*, Federal Trade Commission, 1982.

PRESENTATIONS

"Do State Funded Merit Scholarships for Higher Education Improve High School Graduation Rates?" with Elizabeth Perry-Sizemore, Southern Economic Association Annual Conference, New Orleans, LA, November 2015.

"Sequence of MBA Core Course Completion and Student Performance in an MBA Program," with E. Anthon Eff, Southern Economic Association Annual Conference, New Orleans, LA, November 2015.

"The Music Industry as a Vehicle for Economic Analysis," Southern Economic Association Annual Conference, Atlanta, GA, November 2014.

"The Music Industry as a Vehicle for Economic Analysis," American Economic Association National Conference on Teaching Economics, Chicago, IL, May 2013.

"Supply Innovation and Sales of Recorded Music: 1990-2010," Southern Economic Association Annual Conference, New Orleans, LA, November 2012.

"Econometrics as a Capstone Course in Economics," American Economic Association National Conference on Teaching Economics, Boston, MA, May 2012.

"Music Supply, Chart Turnover, and the Random Copying Hypothesis in the Digital Age," with Shea Slonaker, International Industrial Organization Conference, Arlington, VA, March 2012.

"Econometrics as a Capstone Course in Economics," Southern Economic Association Annual Conference, Washington, DC, November 2011.

"Do State Funded Merit Scholarships for Higher Education Reduce High School Dropout Rates for All Students?" with Elizabeth A. Perry-Sizemore, Southern Economic Association Annual Conference, Washington, DC, November 2011.

"Do State Funded Merit Scholarships for Higher Education Improve Pre-College Academic Performance?" with
Elizabeth A. Perry-Sizemore, Southern Economic Association Annual Conference, Atlanta, GA,
November 2010.

"The Effect of State Funded Merit Scholarships for Higher Education on Pre-College Academic Performance," with
Elizabeth A. Perry-Sizemore, Southern Economic Association Annual Conference, San Antonio, TX,
November 2009.

"The Effect of State Funded Merit Scholarships for Higher Education on High School Graduation Rates," with
Elizabeth A. Perry-Sizemore, Southern Economic Association Annual Conference, Washington, DC,
November 2008.

"Identifying the Best Buys in U.S. Higher Education," with E. Anthon Eff and Reuben Kyle, Southern Economic Association Annual Conference, Washington, DC, November 2008.

"Product Variety and Sales in the Recorded Music Industry: 1990-2005," with Shea Slonaker, International Industrial Organization Conference, Arlington, VA, May 2008.

"Identifying the Best Buys in U.S. Higher Education," with E. Anthon Eff and Reuben Kyle, Academy of Economics and Finance Annual Meeting, Nashville, TN, February 2008.

"Product Variety and Sales in the Recorded Music Industry: 1990-2005," with Shea Slonaker, Academy of Economics and Finance Annual Meeting, Nashville, TN, February 2008.

"Do State Funded Merit Scholarships Induce Students to Learn more in High school?" with Elizabeth A. Perry-
Sizemore, Southern Economic Association Annual Conference, New Orleans, LA, November 2007.

"The Price of Quality: Hedonic Estimation of Implicit Market Models for Higher Education," with Reuben Kyle, Southern Economic Association Annual Conference, New Orleans, LA, November 2007.

"The Shifting Appeal of Sham Litigation: Evidence from Appellate Decisions 1971-2006," International Industrial Organization Conference, Savannah, GA, April 2007.

"The Shifting Appeal of Sham Litigation: Evidence from Appellate Decisions 1980-2006," Scholar's Week Poster Fair, MTSU, April 2007

"Causality Tests for Public School Funding and Performance," Southern Economic Association Meeting, Charleston, SC, November 2006.

"The Price of Quality: Hedonic Estimation of Implicit Market Models for Higher Education," with Reuben Kyle, Southern Economic Association Meeting, Washington, November 2005.

"The Price of Quality: Hedonic Estimation of Implicit Market Models for Higher Education," with Reuben Kyle, International Industrial Organization Conference, Atlanta, April 2005.

"Anticompetitive Litigation and the "Baselessness" Standard for Antitrust Liability," Southern Economic Association Meeting, New Orleans, November 2004.

"The Price of Quality: Hedonic Estimation of Implicit Market Models for Higher Education," with Reuben Kyle, Southern Economic Association Meeting, New Orleans, November 2004.

"VoIP: Let's Ask the Right Questions," Tennessee Regulatory Authority Forum on VoIP, Nashville Public Library, April 30, 2004.

"Telephone Penetration in Tennessee: Are Intrastate Universal Service Policies Effective?" with Aster Rutibablira and David B. Sapper, Southern Economic Association Meeting, San Antonio, TX, November 2003.

"Telephone Penetration in Tennessee: Are Intrastate Universal Service Policies Effective?" with Aster Rutibablira and David B. Sapper, International Industrial Organization Conference, Boston MA, April 4-5, 2003.

"A Critique of Educational Production Functions," Southern Economic Association meeting, New Orleans, LA, November 2002.

"Connecting Tennessee: Bridging the Digital Divide," with Rose M. Gregory, American Economic Association meeting, joint session with the Transportation and Public Utilities Group, Atlanta, GA, January 2002.

"Long Term Contracts as Anticompetitive Devices in Telecommunications," Southern Economic Association Annual Meeting, Tampa, FL, November 2001.

"The Role of Public Power in a Restructured Electric Power Industry," American Economic Association meeting, joint session with the Transportation and Public Utilities Group, Boston, MA, January 2000.

"Universal Telephone Service in Tennessee: A Pre-Competition Assessment," with David Sapper, Southern Economic Association meeting, New Orleans, LA, November 1999.

“Trucks, Planes, Trains, and Wires? Short-haul vs. Long-haul Long Distance Rates in Telecommunications,” with Reuben Kyle, Southern Economic Association meeting, Baltimore, MD, November 1998.

“The Economics of Time as a Resource,” Southern Economic Association meeting, Atlanta, GA, November 1997.

“Cost and Production Duality with Capital Utilization,” Department of Economics Seminar Series, Vanderbilt University, February 1997.

“Maximum Impropriety: The ‘Baselessness’ Standard for Improper Litigation,” Southern Economic Association meeting, Washington, November 1996.

“Cost and Production Duality with Capital Utilization,” Southern Economic Association meeting, Washington, November 1996.

"The Haunting of Universal Service: Open Markets, Efficient Pricing, and the Ghost of the Fair Rate of Return,” Tenth NARUC Biennial Regulatory Information Conference, Columbus, OH, September 1996.

"Productivity Growth in Telecommunications: The Case of Tennessee," Tenth NARUC Biennial Regulatory Information Conference, Columbus, OH, September 1996.

"Productivity Growth in Telecommunications: The Case of Tennessee," Advanced Workshop in Regulation and Public Utility Economics, 15th Annual Conference, Lake George, NY, May 1996.

"A Switching Regime Approach to Measuring the Effects of Technological Change in Ocean Shipping," with Reuben Kyle, Southern Economic Association meeting, New Orleans, November 1995.

"Productivity Growth in Telecommunications: The Case of Tennessee," Southern Economic Association meeting, New Orleans, November 1995.

"Local Service Price Variations and 'Subsidies' in Telecommunications," Southern Economic Association meeting, Orlando, November 1994.

"Dynamic Effects of Regulatory Policy on Intrastate Long Distance Telephone Rates," Southern Economic Association meeting, Orlando, November 1994.

"Single Service Price Variations and 'Subsidies' in the Pricing of Telecommunications Services," Ninth NARUC Biennial Regulatory Information Conference, Columbus, OH, September 1994.

"Suit, Countersuit, and Settlement in Sham Litigation," Annual Meeting of the Midsouth Academy of Economics and Finance, Nashville, February 1994.

"New Evidence on the Effect of Regulation on Intrastate Long Distance Telephone Rates," Annual Meeting of the Midsouth Academy of Economics and Finance, Nashville, February 1994.

"What is Undue Price Discrimination for a Public Utility?" Southern Economic Association meeting, New Orleans, November 1993.

"Regulated Utility Prices and the Preferences of Regulators," with George Sweeney, Southern Economic Association meeting, New Orleans, November 1993.

"A Test for Strategic Behavior Under Rate of Return Regulation," Southern Economic Association meeting, Washington, November 1992.

"New Evidence on the Effect of Regulatory Policy on Intrastate Long Distance Telephone Rates," Southern Economic Association meeting, Washington, November 1992.

"Technological Change and the Production of Ocean Shipping Services," with Reuben Kyle, Atlantic Economic Association meeting, Plymouth, MA, October 1992.

"Negotiating a Transportation Rate Under Threat of Bypass: A Case Study," Eighth Biennial Regulatory Information Conference, Columbus, OH, September 1992.

"A Multinomial Logit Model of Intrastate Trucking Regulation in Tennessee," with Jennifer W. Jose and Reuben Kyle, Midsouth Academy of Economics and Finance annual meeting, Mobile, February 1992.

"Technological Change and the Production of Ocean Shipping Services," with Reuben Kyle, Southern Economic Association meeting, Nashville, November 1991.

"Suit, Countersuit, and Settlement in Sham Litigation Cases," Southern Economic Association meeting, Nashville, November 1991.

"Implementing Third Best Pricing Rules for Natural Gas Distribution Utilties," Southern Economic Association meeting, Nashville, November 1991.

"Trucking Regulation in Tennessee," with Jennifer Jose and Reuben Kyle, Southern Economic Association meeting, Nashville, November 1991.

"Research and Development in Regulated Markets: The Case of Bell Communications Research," Southern Economic Association meeting, New Orleans, November 1990.

"Incentives for Trial and Settlement in Sham Litigation," Southern Economic Association meeting, New Orleans, November 1990.

"Ramsey Prices for Natural Gas Distribution Utilities," Seventh NARUC Biennial Regulatory Information Conference, Columbus, OH, September 1990.

"Intervention as Entry Deterrence: Evidence from Sham Litigation Cases," Seventh NARUC Biennial Regulatory Information Conference, Columbus, OH, September 1990.

"Funding Research and Development in Regulated Industries: The Case of Bell Communications Research," Ninth Annual Conference of the Advanced Workshop in Regulation and Public Utility Economics, New Paltz, NY, May 30 - June 1, 1990.

"Incentives for Trial and Settlement in Sham Litigation," Bureau of Economics Seminar, Federal Trade Commission, February 1990.

"Estimating Ramsey Prices for Natural Gas Utilities," Southern Economic Association meeting, Orlando, November 1989.

"Incentives for Trial and Settlement in Sham Litigation," Department of Economics Seminar Series, Auburn University, November 1989.

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