SOUTHERN BELL TELEPHONE AND TELEGRAPH COMPANY

REBUTTAL TESTIMONY OF WILLIAM E. TAYLOR

BEFORE THE

FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 920260-TL

DECEMBER 18, 1992

I. INTRODUCTION AND SUMMARY

Q. WHAT IS YOUR NAME AND BUSINESS ADDRESS?

A. MY NAME IS WILLIAM E. TAYLOR. I AM SENIOR VICE PRESIDENT OF NATIONAL ECONOMIC RESEARCH ASSOCIATES, INC., (NERA), LOCATED AT ONE MAIN STREET, CAMBRIDGE, MASSACHUSETTS 02142.

Q. WHAT ARE YOUR EDUCATIONAL AND PROFESSIONAL QUALIFICATIONS?

A. I HAVE BEEN AN ECONOMIST FOR OVER TWENTY YEARS. I RECEIVED A B.A. DEGREE IN ECONOMICS (MAGNA CUM LAUDE) FROM HARVARD COLLEGE IN 1968, A MASTER'S DEGREE IN STATISTICS FROM THE UNIVERSITY OF CALIFORNIA AT BERKELEY IN 1970, AND A PH.D. IN ECONOMICS FROM BERKELEY IN 1974, SPECIALIZING IN

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INDUSTRIAL ORGANIZATION AND ECONOMETRICS. FOR THE PAST 16 YEARS, I HAVE TAUGHT AND PUBLISHED RESEARCH IN THE AREAS OF MICROECONOMICS, THEORETICAL AND APPLIED ECONOMETRICS, AND TELECOMMUNICATIONS POLICY AT ACADEMIC INSTITUTIONS (INCLUDING THE ECONOMICS DEPARTMENTS OF CORNELL UNIVERSITY, THE CATHOLIC UNIVERSITY OF LOUVAIN IN BELGIUM, AND THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY) AND AT RESEARCH ORGANIZATIONS IN THE TELECOMMUNICATIONS INDUSTRY (INCLUDING BELL LABORATORIES AND BELL COMMUNICATIONS RESEARCH, INC.). I HAVE PARTICIPATED IN TELECOMMUNICATIONS REGULATORY PROCEEDINGS BEFORE STATE PUBLIC SERVICE COMMISSIONS AND THE FEDERAL COMMUNICATIONS COMMISSION CONCERNING INCENTIVE REGULATION, PRICE CAP REGULATION, PRODUCTIVITY, ACCESS CHARGES, AND PRICING FOR ECONOMIC EFFICIENCY. ATTACHMENT 1 IS A COPY OF MY VITA LISTING PUBLICATIONS AND TESTIMONIES.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. THE PURPOSE OF MY TESTIMONY IS TO ADDRESS THE ECONOMICS OF THE PRICE REGULATION PLAN PROPOSED BY SOUTHERN BELL WITH REGARD TO THE DISCUSSION OF

THESE TOPICS BY SEVERAL INTERVENORS IN THIS DOCKET. IN PARTICULAR, I HAVE BEEN ASKED TO COMMENT ON (1) THE BENEFITS FROM MOVING TO PRICE REGULATION FROM THE CURRENT FLORIDA SHARING PLAN, (2) THE STRUCTURE OF THE SOUTHERN BELL PRICE REGULATION PLAN INCLUDING THE SIZE OF THE PRODUCTIVITY TARGET AND THE NATURE OF EXOGENOUS COST CHANGES, AND (3) IMPUTATION AND POSSIBLE CROSS-SUBSIDIZATION UNDER THE PLAN.

Q. WILL YOU PLEASE SUMMARIZE YOUR TESTIMONY?

A. AS PREVIOUSLY RECOGNIZED BY THIS COMMISSION, REGULATION BASED ON THE FIRM'S RATE OF RETURN PROVIDES INADEQUATE INCENTIVES FOR THE REGULATED FIRM TO MINIMIZE COSTS, TO INVEST IN FUTURE COST-REDUCING OR DEMAND-ENHANCING TECHNOLOGIES, OR TO MARKET ITS SERVICES IN AN INCREASINGLY COMPETITIVE ENVIRONMENT. FROM AN ECONOMIC PERSPECTIVE, PRICE REGULATION IS A MODEST ADJUSTMENT TO THE EXISTING RATE-OF-RETURN-BASED SHARING PLAN WHICH RETAINS MOST OF THE LEGAL AND ADMINISTRATIVE STRUCTURE OF CURRENT REGULATORY MECHANISMS BUT WHICH HELPS TO CORRECT THE DISTORTED INCENTIVES FIRMS FACE UNDER RATE-OF-RETURN-BASED

REGULATION.

THE SOUTHERN BELL PROPOSED PRICE REGULATION PLAN CONTROLS PRICES, NOT PROFITS, SO THAT THE COMPANY RETAINS INCENTIVES TO REDUCE COSTS, EXPAND DEMAND, AND INVEST IN THE FLORIDA PUBLIC SWITCHED NETWORK. IN ORDER THAT PRICES TRACK COSTS AS THEY WOULD IN A COMPETITIVE INDUSTRY, THE PRICE CEILING IS ADJUSTED ANNUALLY TO REFLECT CHANGES IN LONG RUN AVERAGE COST FOR THE TELECOMMUNICATIONS INDUSTRY. BASED ON SEVERAL NATIONAL TOTAL FACTOR PRODUCTIVITY (TFP) STUDIES USING TWO DIFFERENT METHODOLOGIES AND GOVERNMENT AGENCY DATA, THE AVERAGE ANNUAL PRODUCTIVITY DIFFERENTIAL FOR THE TELECOMMUNICATIONS INDUSTRY IS APPROXIMATELY 2 PERCENT. THE PRODUCTIVITY TARGET EMBEDDED IN SOUTHERN BELL'S PROPOSAL IS 4 PERCENT, SO THAT FLORIDA RATEPAYERS WILL RECEIVE IMMEDIATE BENEFITS FROM THE NEW FORM OF REGULATION.

II. THE PROPOSED PRICE REGULATION PLAN

A. INCENTIVES UNDER THE PROPOSED PRICE REGULATION PLAN

Q. DR. KAHN ASSERTS THAT "IT IS NOT AT ALL CLEAR THAT THE INCENTIVES RESULTING FROM AN INCENTIVE REGULATION OR A PRICE CAP PLAN WILL NECESSARILY BE DIFFERENT FROM OR GREATER THAN THOSE ALREADY STEMMING FROM ROR/RB REGULATION," (P. 6, LINES 8-10). DO YOU AGREE WITH HIS ANALYSIS?

A. NO. THERE IS A SIGNIFICANT DIFFERENCE BETWEEN THE INCENTIVES FIRMS FACE UNDER PRICE REGULATION AND THEIR INCENTIVES UNDER RATE OF RETURN REGULATION. PRICE REGULATION BREAKS THE AUTOMATIC LINKS BETWEEN COST INCREASES AND RATE INCREASES AND BETWEEN ADDITIONS TO THE RATE BASE AND ADDITIONS TO EARNINGS. IN THE LONG RUN, BECAUSE SOUTHERN BELL'S INCENTIVES WOULD BE MORE CLOSELY ALIGNED WITH THOSE OF FIRMS IN COMPETITIVE MARKETS, I WOULD EXPECT FLORIDA CONSUMERS TO BENEFIT FROM LOWER PRICES, A HIGHER RATE OF PRODUCTIVITY GROWTH, AND A TELEPHONE COMPANY MORE RESPONSIVE TO THE NEEDS OF THE MARKET.

IN ECONOMIC THEORY, THERE ARE A NUMBER OF PROBLEMS WITH THE PERFORMANCE OF TRADITIONAL RATE OF RETURN

(ROR) REGULATION FOR LOCAL EXCHANGE TELEPHONE COMPANIES. IN THEORY, ROR REGULATION IMITATES COMPETITION BY LIMITING THE REGULATED FIRM TO THE RATE OF RETURN THAT WOULD BE EARNED IF THE MARKET WERE COMPETITIVE. HOWEVER, LIMITING EARNINGS TO THEIR COMPETITIVE LEVEL DOES NOT MAKE ROR-REGULATED FIRMS BEHAVE THE SAME WAY THAT COMPETITIVE FIRMS BEHAVE. PRICES, COSTS, INVESTMENT, PRODUCTIVITY GROWTH, AND SERVICE QUALITY ARE NOT DIRECTLY CONTROLLED BY ROR REGULATION, AND THE ROR-REGULATED FIRM HAS DIFFERENT INCENTIVES IN THESE AREAS FROM THOSE OF A FIRM IN COMPETITIVE MARKETS. MOST CURRENT REGULATORY REFORM ATTEMPTS TO REMOVE THESE INCENTIVE DISTORTIONS, PARTICULARLY IN FOUR AREAS: COST REDUCTION, DEMAND EXPANSION, EFFICIENT CHOICE OF INPUTS AND TECHNOLOGY, AND SERVICE QUALITY.

Q. DO UNCERTAINTY AND REGULATORY LAG MITIGATE THE INCENTIVE PROBLEMS OF ROR REGULATION, AS CLAIMED BY DR. KAHN (P. 6, LINES 11-22)?

A. NO. WHILE IT IS TRUE THAT UNCERTAINTY AND REGULATORY LAG CAUSE ROR-REGULATED FIRMS TO EXPERIENCE SOME VARIATION IN EARNINGS, THE INCENTIVES FACED BY SUCH A FIRM ARE VERY DIFFERENT

FROM FIRMS IN UNREGULATED INDUSTRIES. EVERY ACTION THAT A ROR-REGULATED FIRM TAKES TO INCREASE ITS EARNINGS DIRECTLY AFFECTS THE LIKELIHOOD THAT THE REGULATOR WILL REQUIRE A RATE REDUCTION IN THE NEXT PERIOD. SIMILARLY, EVERY ERROR THE ROR-REGULATED FIRM MAKES THAT RESULTS IN LOWER EARNINGS RAISES THE LIKELIHOOD OF INCREASED RATES IN THE NEXT PERIOD. THIS COST-PLUS COMPONENT OF ROR REGULATION BLUNTS THE FORCE OF THE MARKET ON SUCH FIRMS.

Q. DR. CHESSLER CLAIMS THAT "SINCE THE COMPANY CAN RAISE RATES IF INFLATION EXCEEDS ITS PRODUCTIVITY GAINS, IT DOES NOT HAVE TO CONCERN ITSELF WITH COST SAVINGS THAT ARE NOT REFLECTED IN PRODUCTIVITY GAINS. IT NO LONGER HAS AN INCENTIVE TO SEEK OUT SUCH COST SAVINGS," (P. 57, LINES 9-13). DO YOU AGREE?

A. NO, UNDER THE PROPOSED PLAN, THE COMPANY <u>DOES</u> HAVE AN INCENTIVE TO SEEK OUT COST SAVINGS. IT IS TRUE, AS DR. CHESSLER CLAIMS, THAT IF INFLATION EXCEEDS THE PRODUCTIVITY TARGET IN THE PLAN, THEN THE PRICE CAP INDEX WILL INCREASE. AND, OF COURSE, IF MARKET CONDITIONS PERMIT, THE FIRM CAN THEN RAISE PRICES. IT IS ALSO TRUE, HOWEVER, THAT SINCE THE

PRODUCTIVITY TARGET IS FIXED OVER TIME, ANY KIND OF COST SAVINGS THE FIRM EXPERIENCES WILL CAUSE ITS EARNINGS TO BE HIGHER THAN THEY WOULD HAVE BEEN ABSENT THE COST SAVINGS. IN ADDITION, IF THE FIRM EXCEEDS ITS PROPOSED PRODUCTIVITY TARGET OF 4 PERCENT, ITS EARNINGS WILL ACTUALLY INCREASE OVER TIME. THUS, IN CONTRAST TO DR. CHESSLER'S CLAIMS, IF THE COMPANY (1) "RENEGOTIATES ITS LEASES TO SAVE MONEY" (P. 57, LINES 22-23), ITS EARNINGS UNDER THE PLAN WILL BE HIGHER THAN IF IT DOES NOT RENEGOTIATE LEASES, AND (2) "ACHIEVES SAVINGS IN INVESTMENT FROM ISDN OR SOME OTHER TECHNOLOGY REDUCING ITS NEED FOR LOCAL LOOPS" (P. 57, LINES 24-25), ITS EARNINGS WILL ALSO BE HIGHER--DOLLAR FOR DOLLAR--THAN IF IT DOES NOT INTRODUCE COST-REDUCING TECHNOLOGY.

DR. CHESSLER APPEARS TO BELIEVE THAT SOUTHERN BELL'S PROPOSED PRICE REGULATION PLAN TIES EARNINGS INCREASES TO INCREASES IN MEASURED PRODUCTIVITY. THAT BELIEF IS NOT CORRECT. IN SOUTHERN BELL'S PROPOSAL, THE PRODUCTIVITY TARGET--BASED ON THE HISTORICAL DIFFERENCE BETWEEN TOTAL FACTOR PRODUCTIVITY GROWTH OF THE TELECOMMUNICATIONS INDUSTRY AND THE U.S. AS A WHOLE--IS FIXED FOR THE

LIFE OF THE PLAN. IF SOUTHERN BELL EXCEEDS THIS TARGET, ITS EARNINGS WILL INCREASE OVER TIME; OTHERWISE THEY WILL DECREASE.

Q. MR. CICCHETTI ASSERTS THAT "AN INCENTIVE REGULATION PLAN THAT TIES AN APPROPRIATE REWARD FOR EFFICIENT PRODUCTION TO SPECIFIC EFFICIENCY GAINS IS A BETTER PROXY OF A PURELY COMPETITIVE ENVIRONMENT AND IS SUPERIOR TO AN INCENTIVE PLAN THAT PROVIDES A REWARD FOR CIRCUMSTANCES BEYOND THE COMPANY'S CONTROL OR FOR SELF-SERVING MANIPULATION." (P. 10, LINES 8-14). IN UNREGULATED MARKETS, ARE REWARDS TIED TO SPECIFIC EFFICIENCY GAINS UNDER THE CONTROL OF THE COMPANY?

A. IN GENERAL, NO. COMPETITION REWARDS EFFICIENT FIRMS AND PUNISHES INEFFICIENT FIRMS, BUT EARNINGS IN UNREGULATED MARKETS VARY WITH UNCONTROLLABLE FACTORS SUCH AS ECONOMIC CONDITIONS, CHANGES IN TASTE, AND THE SUCCESS OR FAILURE OF COMPETITORS. IN ADDITION, IT WOULD BE A HOPELESS TASK FOR THE REGULATOR TO IDENTIFY AND REWARD PARTICULAR EFFICIENCY GAINS AND PUNISH PARTICULAR EFFICIENCY LOSSES. THE PREMISE OF INCENTIVE REGULATION IS TO SET UP SIMPLE INCENTIVES SO THAT THE FIRM WILL

BEHAVE IN THE DESIRED MANNER WHILE PURSUING ITS OWN SELF-INTEREST.

Q. ON PAGES 17-22, MR. CICCHETTI PROPOSES A DIFFERENT INCENTIVE REGULATION PLAN IN WHICH THE COMPANY IS REWARDED FOR REDUCING ITS COST PER ACCESS LINE BELOW THE AVERAGE COST PER ACCESS LINE OF COMPARABLE TELEPHONE COMPANIES. WHAT ARE THE INCENTIVE PROPERTIES OF SUCH A PLAN?

A. INCENTIVES UNDER THIS PLAN ARE VERY DIFFERENT FROM THOSE FACING FIRMS IN UNREGULATED MARKETS. THE MOST IMPORTANT DIFFERENCE IS THAT MR. CICCHETTI'S PLAN ENCOURAGES COST REDUCTION; IT DOES NOT ENCOURAGE--INDEED, IT DISCOURAGES--INNOVATIVE USES OF THE NETWORK TO INCREASE USAGE AND REVENUES, MARKETING TO EXPAND DEMAND FOR EXISTING SERVICES, AND IMPROVEMENTS IN SERVICE QUALITY AND CUSTOMER SATISFACTION. THE REASON IS THAT THE FINANCIAL PERFORMANCE OF THE FIRM IS TIED TO REDUCING COSTS PER ACCESS LINE. UNLIKE FIRMS IN UNREGULATED MARKETS, EXPANDING DEMAND IS NOT A SOURCE OF EXPANDED EARNINGS. PRODUCTIVITY GROWTH AND EFFICIENCY ARE MEASURED AS THE DIFFERENCE BETWEEN THE GROWTH IN OUTPUTS AND THE GROWTH IN INPUTS; A

PLAN THAT IGNORES THE GROWTH IN OUTPUT AND REWARDS ONLY REDUCTIONS IN THE GROWTH OF INPUTS SEVERELY DISTORTS THE INCENTIVES OF THE REGULATED FIRM.

AN ADDITIONAL DISTORTION OF INCENTIVES IN MR. CICCHETTI'S PLAN COMES FROM THE FACT THAT ACCESS LINES ARE TAKEN TO BE THE ONLY RELEVANT OUTPUT. A FIRM WILL BE REWARDED FOR INCREASING THE NUMBER OF ACCESS LINES WHILE HOLDING COSTS CONSTANT, BUT IT WILL RECEIVE NO REWARD FROM EXPANDING USAGE OF THE NETWORK OR OTHER TELECOMMUNICATIONS SERVICES. SUCH DISTORTED INCENTIVES WILL NOT RESULT IN THE PRODUCTION OF THE MOST EFFICIENT MIX OF OUTPUT AND WILL NOT BENEFIT THE RATEPAYERS OF FLORIDA.

Q. MR. GILLAN STATES THAT THE "PRINCIPAL FLAW WITH THE PLAN IS THAT IT ELIMINATES COST AS A CRITERION FOR JUDGING INDIVIDUAL PRICES, AND ELIMINATES PROFITS AS A STANDARD TO EVALUATE OVERALL RATE LEVELS" (P. 33, LINES 17-19). DO YOU AGREE?

A. NO. THESE CHARACTERISTICS OF THE PLAN DIFFERENTIATE IT FROM THE ROR-BASED SHARING PLAN CURRENTLY IN PLACE IN FLORIDA AND, IRONICALLY, THESE ARE THE VERY FEATURES THAT GENERATE AN

IMPROVEMENT IN INCENTIVES. THE MAJOR INCENTIVE DISTORTIONS OF ROR REGULATION STEM FROM THE AUTOMATIC LINKAGE OF COSTS AND PRICES ON THE ONE HAND AND INVESTMENT AND ALLOWED EARNINGS ON THE OTHER. LINKING COSTS TO PRICES DILUTES THE FIRM'S INCENTIVE TO MINIMIZE THOSE COSTS, AND TYING ALLOWED EARNINGS TO INVESTMENT DISTORTS THE FIRM'S INCENTIVE TO MODERNIZE ITS NETWORK. THE CURRENT FLORIDA SHARING PLAN WEAKENS THE LINK BETWEEN ALLOWED EARNINGS AND INVESTMENT AND PERMITS THE FINANCIAL PERFORMANCE OF THE FIRM TO VARY WITH ITS PERFORMANCE IN THE MARKET. THE PROPOSED PRICE REGULATION PLAN FURTHER BREAKS THE AUTOMATIC LINK BETWEEN PRICES AND COSTS (WITHIN LIMITS), SO THAT THE FIRM'S INCENTIVES TO REDUCE COSTS AND EXPAND DEMAND ARE IMPROVED.

Q. DR. KAHN CLAIMS ON PAGES 16-19 THAT "THERE IS NO CREDIBLE EVIDENCE SUGGESTING THAT INCENTIVE REGULATION HAS HAD A SIGNIFICANT IMPACT ON ...THE PACE AT WHICH NEW TECHNOLOGY IS DEPLOYED IN THE NETWORK" (P. 19, LINES 6-8). DO YOU AGREE?

A. NO, DR. KAHN'S STUDY HAS AT LEAST THREE FLAWS THAT ARE SUFFICIENTLY SERIOUS THAT NO CORRECT

CONCLUSIONS CAN BE DRAWN FROM HIS WORK. HIS STUDY ATTEMPTS TO RELATE CHANGES IN THE RATE OF DIFFUSION OF NEW TECHNOLOGY TO THE PRESENCE OR ABSENCE OF INCENTIVE REGULATION. HE COMPARES MEASURES OF TECHNOLOGY DIFFUSION AND INCENTIVE REGULATION USING DATA FOR THE RBOCS AND CONCLUDES THAT THERE IS NO RELATIONSHIP BETWEEN RAPID DIFFUSION OF TECHNOLOGY AND THE PRESENCE OF INCENTIVE REGULATION.

THE FIRST OBVIOUS FLAW IN THIS ANALYSIS IS THAT INCENTIVE REGULATION IS A CHARACTERISTIC OF REGULATING JURISDICTIONS NOT OF RBOCS. COMPARING DATA ACROSS RBOCS GIVES AN INCORRECT PICTURE OF THE RELATIONSHIP BETWEEN TECHNOLOGY DIFFUSION AND INCENTIVE REGULATION ACROSS STATES. IN TECHNICAL TERMS, THE EXPLANATORY VARIABLE OF INTEREST IN HIS EQUATIONS (THE PRESENCE OF INCENTIVE REGULATION) IS MEASURED WITH ERROR. IT IS A BASIC RESULT OF ELEMENTARY ECONOMETRICS THAT ERRORS OF MEASUREMENT IN THE EXPLANATORY VARIABLES LEAD TO BIASED AND INCONSISTENT ESTIMATES OF THE COEFFICIENTS. IN OTHER WORDS, THE OBSERVED RELATIONSHIP BETWEEN TECHNOLOGY DIFFUSION AND INCENTIVE REGULATION ACROSS RBOCS DOES NOT MEASURE THE TRUE RELATIONSHIP BETWEEN THE VARIABLES ACROSS STATES.

DR. KAHN'S SECOND ERROR IS TO IGNORE THE TIMING OF THE ADOPTION OF INCENTIVE REGULATION PLANS AND THE DIFFUSION OF NEW TECHNOLOGY. HIS ANALYSIS MAKES NO USE OF THE DATA COMPARING TECHNOLOGY DIFFUSION AND INCENTIVE REGULATION OVER TIME FOR EACH BOC. IT IS WELL KNOWN THAT USING MORE DATA--AND ADDITIONAL SOURCES OF VARIATION IN THE DATA--GIVES A MORE PRECISE ESTIMATE OF THE RELATIONSHIP IN QUESTION. DR. KAHN'S CONCLUSION FROM HIS DATA WAS THAT A PRECISE RELATIONSHIP COULD NOT BE FOUND; SUCH CONCLUSIONS CAN ALWAYS BE OBTAINED IF LARGE AMOUNTS OF DATA ARE EXCLUDED FROM THE ANALYSIS.

THIRD, DR. KAHN'S STUDY IGNORES THE PROBLEM OF REVERSE CAUSALITY. DR. KAHN'S MODEL ASSUMES THAT THE ADOPTION OF INCENTIVE REGULATION FOR AN RBOC LEADS TO A HIGHER RATE OF DIFFUSION OF NEW TECHNOLOGY (DIGITAL OR SS7-EQUIPPED ACCESS LINES). WITHOUT FURTHER INFORMATION HOWEVER, IT IS POSSIBLE THAT THE CAUSES AND EFFECTS ARE REVERSED--THAT ADOPTION OF INCENTIVE REGULATION IS A RESPONSE TO INADEQUATE DIFFUSION OF NEW TECHNOLOGY. THERE ARE STATISTICAL METHODS TO OVERCOME THIS PROBLEM, BUT THE SIMPLE LEAST SQUARES ESTIMATES OF DR. KAHN'S CROSS-SECTION EQUATIONS CANNOT. USING HIS METHOD,

THERE IS NO WAY TO DISTINGUISH ONE SCENARIO FROM THE OTHER. IN TECHNICAL LANGUAGE, THE EXPLANATORY VARIABLES IN DR. KAHN'S EQUATIONS ARE CORRELATED WITH THE DISTURBANCES IN THE EQUATIONS, AND HIS LEAST SQUARES ESTIMATES ARE BIASED AND INCONSISTENT. WE CANNOT DRAW RELIABLE CONCLUSIONS FOR ECONOMIC POLICY FROM A STUDY THAT COMMITS THIS ERROR.

Q. ON PAGE 19, DR. KAHN CONCLUDES THAT "THE DATA AVAILABLE AT THIS POINT DO NOT SUPPORT THE CLAIM THAT ANY POSITIVE EFFECTS HAVE RESULTED [FROM INCENTIVE REGULATION]". ARE YOU AWARE OF ANY EVIDENCE CONCERNING THE RELATIONSHIP BETWEEN THE ADOPTION OF INCENTIVE REGULATION AND THE RATE OF DIFFUSION OF NEW TECHNOLOGY IN THE PUBLIC SWITCHED NETWORK?

A. YES. UNDER MY DIRECTION, NERA PERFORMED A POOLED TIME-SERIES CROSS-SECTION STUDY WHICH EXAMINED THE RELATIONSHIP BETWEEN FORMS OF INCENTIVE REGULATION FOR LECS AND THE RATE AND LEVEL OF DIFFUSION OF NEW TECHNOLOGY IN THE LOCAL NETWORK. BECAUSE THE RELATIONSHIP WAS MEASURED AT THE STATE LEVEL, THE ERROR IN THE MEASUREMENT OF THE PRESENCE OF

INCENTIVE REGULATION WAS MINIMIZED. BY USING STATISTICAL METHODS THAT COMBINE TIME-SERIES DATA WITH CROSS-SECTION DATA, WE HAD MANY MORE OBSERVATIONS THAN DR. KAHN USED, AND, CONSEQUENTLY, WE OBTAINED A MUCH MORE PRECISE ESTIMATE OF THE RELATIONSHIP BETWEEN TECHNOLOGY DIFFUSION AND INCENTIVE REGULATION. FINALLY, OUR STATISTICAL METHOD AND OUR POOLED TIME-SERIES CROSS-SECTION DATA ALLOWED US TO ACCOUNT FOR THE REVERSE CAUSALITY PROBLEM. OUR ESTIMATES SPECIFICALLY CONTROLLED FOR UNOBSERVABLE STATE-SPECIFIC EFFECTS SUCH AS THE EFFECT OF SLOW TECHNOLOGY DIFFUSION ON THE LIKELIHOOD OF ADOPTING AN INCENTIVE REGULATION PLAN.

WE OBTAINED MODERNIZATION DATA FOR THE LECS BY MEASURING THE PROPORTION OF (1) LINES SERVED BY DIGITAL SWITCHES, (2) LOOP TRANSMISSION FACILITIES WHICH ARE OPTICAL FIBER, (3) LINES SERVED BY SIGNALLING SYSTEM 7 (SS7) SWITCHES, AND (4) LINES SERVED BY SWITCHES SUPPORTING ISDN. ACTUAL AND FORECASTED DATA WERE OBTAINED BY COMPANY FOR EVERY YEAR FROM 1980 TO 1994. INFORMATION ON THE TYPE OF REGULATION FACED BY EACH FIRM IN EACH YEAR WAS TAKEN FROM INDUSTRY SOURCES, UPDATED FOR THE

CURRENT PURPOSE. RESULTS FOR ALL FOUR MEASURES OF MODERNIZATION SHOWED THAT ADOPTION OF INCENTIVE REGULATION PLANS LED TO A MORE RAPID DIFFUSION OF NEW TECHNOLOGIES IN THE LOCAL EXCHANGE NETWORK. ON AVERAGE, FIRMS UNDER INCENTIVE REGULATION ACCELERATED DEPLOYMENT OF NEW TECHNOLOGY BY BETWEEN SIX MONTHS AND ONE YEAR, RELATIVE TO FIRMS UNDER TRADITIONAL RATE OF RETURN REGULATION. DETAILS OF THAT STUDY ARE PROVIDED IN ATTACHMENT 4 TO MY TESTIMONY.

B. EXOGENOUS COST CHANGES UNDER THE PRICE REGULATION PLAN

Q. ON PAGE 12 (LINES 15-18), MR. CRESSE ASKS THE COMMISSION TO "CONSIDER WHAT APPROACH IT SHOULD TAKE" FOR THE EXOGENOUS COST TREATMENT OF INCOME, PROPERTY OR AD VALOREM TAXES. WHAT IS THE PROPER ECONOMIC TREATMENT OF SUCH TAXES IN A PRICE CAP PLAN?

A. FIRST, CHANGES IN TAX PAYMENTS DO NOT QUALIFY FOR EXOGENOUS COST TREATMENT IN THE PRICE REGULATION PLAN. THE REGULATED FIRM, LIKE ITS UNREGULATED BRETHREN, SHOULD BE GIVEN THE INCENTIVE TO CONDUCT ITS AFFAIRS SO AS TO MAXIMIZE ITS EARNINGS AFTER

TAXES. AUTOMATIC PASS-THROUGH OF TAX PAYMENT CHANGES AS AN EXOGENOUS COST CHANGE WOULD REMOVE THAT INCENTIVE FOR THE PRICE REGULATED FIRM.

ON THE OTHER HAND, CHANGES IN TAX LAWS--BECAUSE THEY ARE BEYOND THE CONTROL OF THE REGULATED FIRM--DO QUALIFY FOR EXOGENOUS COST TREATMENT. ATTACHMENT 2 TO MY TESTIMONY SHOWS THAT THE PROPER EXOGENOUS COST ADJUSTMENT IS THE DIFFERENCE BETWEEN THE EFFECT OF THE TAX LAW CHANGE ON THE REGULATED FIRM AND ON THE AVERAGE FIRM IN THE U.S. ECONOMY. USING THIS DIFFERENCE--RATHER THAN JUST THE EFFECT OF THE CHANGE ON THE REGULATED FIRM--REMOVES POSSIBLE DOUBLE-COUNTING OF THE EFFECT OF THE CHANGE THROUGH ITS EFFECT ON THE RATE OF INFLATION IN THE PRICE CAP FORMULA.

Q. MR. KING OBJECTS "TO THE AUTOMATIC FLOW-THROUGH OF THE EFFECT OF DEPRECIATION CHANGES" (P. 5, LINES 22-23) BECAUSE DEPRECIATION RATES ARE UNDER THE CONTROL OF THE REGULATED FIRM. DO YOU AGREE WITH THIS REASONING?

A. NO. MR. KING FAILS TO DISTINGUISH BETWEEN CHANGES IN DEPRECIATION EXPENSES (E.G. AVERAGE REMAINING

LIVES, WHICH ARE UNDER THE COMPANY'S CONTROL) AND CHANGES IN DEPRECIATION RULES (E.G. THE ASSIGNED USEFUL LIVES, WHICH ARE NOT UNDER THE COMPANY'S CONTROL). HE IS CORRECT THAT THE COMPANY CONTROLS ITS ACTUAL DEPRECIATION RATES THROUGH INVESTMENT IN DIFFERENT TYPES OF EQUIPMENT AND THROUGH RETIREMENTS. HOWEVER, THE COMPANY DOES NOT CONTROL THE CHANGE IN DEPRECIATION RULES THAT OCCURS APPROXIMATELY EVERY THREE YEARS. THE EFFECT ON COSTS OF THOSE CHANGES IN THE RULES IS A LEGITIMATE EXOGENOUS COST CHANGE IN THE PRICE REGULATION PLAN.

CHANGES IN DEPRECIATION RULES ARE COMPLETELY ANALOGOUS TO CHANGES IN SEPARATIONS RULES, WHICH MR. KING ACKNOWLEDGES ARE LEGITIMATE EXOGENOUS COST CHANGES. THE COMPANY CONTROLS THE LEVEL OF INTRASTATE COSTS (THROUGH THE BUSINESS DECISIONS UNDER ITS CONTROL), SO CHANGES IN INTRASTATE COSTS CANNOT BE TREATED AS EXOGENOUS. NONETHELESS, THE CHANGE IN INTRASTATE COSTS CAUSED BY A CHANGE IN THE SEPARATIONS RULES IS--WE ALL AGREE--EXOGENOUS AND SHOULD BE FLOWED-THROUGH, POSITIVELY OR NEGATIVELY, IN THE PRICE REGULATION PLAN. SIMILARLY, EVEN THOUGH THE LEVEL OF DEPRECIATION EXPENSES IS CONTROLLED BY THE FIRM, THE CHANGE IN

DEPRECIATION EXPENSE CAUSED BY A CHANGE IN THE DEPRECIATION RULES IS NOT UNDER THE CONTROL OF THE FIRM AND IS A LEGITIMATE EXOGENOUS COST CHANGE.

C. PRICING FLEXIBILITY UNDER THE PRICE REGULATION PLAN

Q. DR. CHESSLER CLAIMS THAT THE PROPOSED PRICE REGULATION PLAN IS ANTICOMPETITIVE BECAUSE IT PERMITS THE COMPANY TOO MUCH FLEXIBILITY TO INCREASE OR DECREASE PRICES WITHOUT COST SUPPORT (P. 58, LINES 12-16). DO YOU AGREE?

A. NO. AS COMPETITION COMES TO DIFFERENT TELECOMMUNICATIONS MARKETS IN FLORIDA, SOUTHERN BELL WILL NEED THE ABILITY TO REBALANCE ITS PRICES TO RESPOND TO COMPETITION. SUCH RESPONSES ARE NOT ANTICOMPETITIVE: AN UNREGULATED FIRM IN COMPETITIVE MARKETS SETS ITS PRICES ABOVE INCREMENTAL COST BY A LARGER PROPORTION IN THOSE MARKETS OR MARKET NICHES WHERE IT HAS A COMPETITIVE ADVANTAGE, COMPARED WITH MARKETS WHERE IT HAS NO ADVANTAGE. AS LONG AS PRICES REMAIN COMPENSATORY (ABOVE LONG RUN INCREMENTAL COST), SUCH PRICE CHANGES ARE PROCOMPETITIVE.

III. THE PRODUCTIVITY OFFSET

Q. DR. KAHN STATES THAT THE PRODUCTIVITY TARGET SHOULD BE "NO LESS THAN THE AVERAGE PRODUCTIVITY GAIN EXPERIENCED BY THE COMPANY OVER A RECENT TIME PERIOD." (P. 30, LINES 11-13). DR. CHESSLER STATES THAT "THE APPROPRIATE OFFSET IS THE INDUSTRY AVERAGE GAIN" (P. 46, LINES 19-20). IGNORING THEIR DIFFERENT RECOMMENDATIONS OF COMPANY AND INDUSTRY COMPARISONS, SHOULD THE PRODUCTIVITY TARGET BE SET AT OR ABOVE THE HISTORICAL PRODUCTIVITY GROWTH, AS BOTH DRS. KAHN AND CHESSLER SUGGEST?

A. NO, THE PRODUCTIVITY OFFSET IS NOT THE HISTORICAL LEVEL OF PRODUCTIVITY GROWTH OF THE FIRM OR THE INDUSTRY. THE MECHANICS OF THE PRICE CAP ADJUSTMENT FORMULA REQUIRE THAT THE PRODUCTIVITY TARGET BE SET AT THE DIFFERENCE BETWEEN THE PRODUCTIVITY GROWTH OF THE FIRM OR INDUSTRY AND THE PRODUCTIVITY GROWTH OF THE U.S. AS A WHOLE. THIS FACT IS EVIDENT FROM THE DERIVATION OF THE PRICE CAP FORMULA WHICH IS SHOWN IN ATTACHMENT 2 TO MY TESTIMONY. IT IS COMMON KNOWLEDGE AMONG EXPERTS IN INCENTIVE REGULATION AND REGULATORS WHO USE PRICE CAP PLANS. SEE, FOR EXAMPLE,

(1) PAGE 82 OF "PRODUCTIVITY AND PRICE CAPS IN

TELECOMMUNICATIONS," BY JOHN E. KWOKA, JR., IN PRICE CAPS AND INCENTIVE REGULATION IN TELECOMMUNICATIONS (MICHAEL A. EINHORN ED.), BOSTON, KLUWER ACADEMIC PUBLISHERS, 1991; (2) SECTION 4 OF "CONSTANT AND VARIABLE PRODUCTIVITY ADJUSTMENTS FOR PRICE-CAP REGULATION," BY FERENC KISS, ALSO IN THE EINHORN VOLUME; AND (3) PARAGRAPH 64 OF THE FEDERAL COMMUNICATIONS COMMISSION, SECOND REPORT AND ORDER, CC DOCKET 87-313, RELEASED OCTOBER 4, 1990.

Q. ON PAGES 30-31, DR. KAHN STATES THAT "BECAUSE OF DEMAND STIMULATION, ACTUAL PRODUCTIVITY GAINS CAN FALL SHORT OF THE TARGET AND EARNINGS REMAIN LARGELY UNAFFECTED." IS DEMAND STIMULATION FROM PRICE REDUCTIONS INCLUDED IN THE HISTORICAL MEASURE OF THE PRODUCTIVITY OFFSET?

A. YES. PRODUCTIVITY GROWTH IS SIMPLY THE DIFFERENCE IN THE GROWTH RATES OF AGGREGATE OUTPUT AND AGGREGATE INPUT. STIMULATION FROM PRICE REDUCTIONS IN THE PAST HAS CONTRIBUTED TO HIGHER PRODUCTIVITY GROWTH IN THE PAST, TO THE EXTENT THAT THE GROWTH IN OUTPUT FROM DEMAND STIMULATION EXCEEDS THE GROWTH IN INPUTS TO SERVE THAT ADDITIONAL DEMAND.

COMPETITION MAY LEAD TO LARGER RATE REDUCTIONS IN THE FUTURE, AND THUS THE EFFECT OF STIMULATION MAY BE LARGER IN THE FUTURE THAN IN THE PAST. HOWEVER, THE MAIN EFFECT OF COMPETITION AND LOWER RATES IS TO MAKE ANY HISTORICAL PRODUCTIVITY TARGET MORE DIFFICULT TO ACHIEVE RATHER THAN LESS. AS COMPETITION COMES TO FLORIDA TOLL MARKETS, WE WOULD EXPECT TO SEE SOUTHERN BELL LOWER ITS TOLL PRICES, AND THE EFFECT OF THIS RESPONSE TO COMPETITION WILL BE TO REDUCE MEASURED PRODUCTIVITY GROWTH. THE REASON IS THAT TOLL SERVICES ARE CURRENTLY GROWING MORE RAPIDLY THAN OTHER SOUTHERN BELL SERVICES AND HAVE A HIGHER PRICE-COST MARGIN. AS SHOWN IN ATTACHMENT 2, WHEN TOLL PRICES COME DOWN RELATIVE TO OTHER PRICES, THE MARGIN WILL DECREASE AND THE WEIGHT OF TOLL IN THE MEASURE OF AGGREGATE OUTPUT WILL DECREASE. IF 4 PERCENT IS AN APPROPRIATE PRODUCTIVITY TARGET BASED ON HISTORICAL PRODUCTIVITY MEASURES, THEN 4 PERCENT WILL BE MORE DIFFICULT TO ACHIEVE IN THE FUTURE AFTER PRICE REDUCTIONS FOR SERVICES WHICH ARE RELATIVELY HIGH-MARGIN, FASTER-GROWING, AND DEMAND-ELASTIC.

Q. ON PAGES 32-34 (AND EXHIBIT MHK-4), DR. KAHN PURPORTS TO DERIVE A MINIMUM PRODUCTIVITY OFFSET OF

5.6 PERCENT FROM A SOUTHERN BELL ATTRITION ESTIMATE OF MR. MCCLELLAN. IS DR. KAHN'S ANALYSIS CORRECT?

A. NO. IN THE FIRST PLACE, DR. KAHN'S EXHIBIT (MHK-4) ATTEMPTS TO CALCULATE A PRODUCTIVITY TARGET FOR A PRICE CAP PLAN. IN CONTRAST, MR. MCCLELLAN'S ATTRITION ANALYSIS ESTIMATES THE CHANGE IN REVENUE REQUIREMENTS AND EARNINGS FROM 1991 TO 1993 BASED ON THE RECENT HISTORICAL EXPERIENCE OF THE COMPANY. THE TWO CALCULATIONS ARE NOT THE SAME, AND THE PROJECTED CHANGE IN COST PER ACCESS LINE IS NOT A REASONABLE ESTIMATE OF EITHER THE APPROPRIATE CHANGE IN SOUTHERN BELL'S OUTPUT PRICES OR THE PRODUCTIVITY TARGET IN THE PRICE REGULATION PLAN. THE CHANGE IN COST PER ACCESS LINE DOES NOT MEASURE THE APPROPRIATE CHANGE IN SOUTHERN BELL'S PRICES BECAUSE SOUTHERN BELL PRODUCES OUTPUTS OTHER THAN ACCESS LINES. IN ORDER FOR THE CHANGE IN PRICES TO TRACK THE CHANGE IN COSTS, WE MUST MEASURE THE CHANGE IN COST WITH RESPECT TO ALL OUTPUTS.

SECOND, EVEN IF THE CHANGE IN COST PER ACCESS LINE COULD BE USED TO ESTIMATE A TARGET CHANGE IN SOUTHERN BELL'S PRICES, WE WOULD STILL HAVE TO ADD THE ANNUAL RATE OF INFLATION AND SUBTRACT THE

AVERAGE PRODUCTIVITY GROWTH FOR THE U.S. IN ORDER TO CALCULATE THE PRODUCTIVITY TARGET FOR THE PRICE REGULATION PLAN. WE USE GNP-PI TO MEASURE INFLATION AND THE BUREAU OF LABOR STATISTICS (BLS) MEASURE OF TOTAL FACTOR PRODUCTIVITY GROWTH FOR THE U.S. PRIVATE BUSINESS SECTOR TO ADJUST FOR NATIONAL PRODUCTIVITY GROWTH. FIGURE 1 SHOWS AN AVERAGE PRODUCTIVITY OFFSET OF ABOUT 3% OVER THE POST-DIVESTITURE PERIOD, CALCULATING THE PRODUCTIVITY TARGET FROM DR. KAHN'S CHANGE IN REVENUE REQUIREMENT PER ACCESS LINE. NOTE THAT THE "CONSTANT DEPRECIATION" CALCULATION IS NOT RELEVANT FOR DETERMINING THE PRODUCTIVITY TARGET BECAUSE SOUTHERN BELL DOES NOT PROPOSE TO FLOW THROUGH FUTURE CHANGES IN DEPRECIATION RATES AS EXOGENOUS COST ADJUSTMENTS. FIGURE 1 ALSO SHOWS THAT THE PRODUCTIVITY OFFSET--CALCULATED FROM THE AVERAGE REVENUE REQUIREMENT PER ACCESS LINE--WAS LARGER IN THE 1986-1991 PERIOD OF THE INCENTIVE REGULATION PLAN THAN DURING THE 1984-1986 PERIOD PRECEDING IT.

Q. DR. CHESSLER PROPOSES TO BASE A PRODUCTIVITY TARGET ON LONG RUN AVERAGE PRODUCTIVITY GROWTH (P. 83, LINE 10). DO YOU AGREE?

A. YES. PRODUCTIVITY GROWTH IS TOO VOLATILE TO DETERMINE A FAIR TARGET THAT CAN BE HELD CONSTANT OVER A REASONABLE LENGTH OF TIME. TRUE PRODUCTIVITY GROWTH FOR A FIRM, AN INDUSTRY, OR THE U.S. AS A WHOLE VARIES A GREAT DEAL FROM YEAR TO YEAR BECAUSE OF PRODUCTIVITY-INCREASING OR PRODUCTIVITY-DECREASING ACTIVITIES THAT OCCUR LESS FREQUENTLY THAN ONCE PER YEAR. FOR EXAMPLE, SUPPOSE EVERY FIVE YEARS A FIRM UNDERGOES A SIGNIFICANT RESTRUCTURING IN WHICH REDUNDANT WORKERS AND MANAGERS ARE ELIMINATED FROM THE PAYROLL. MEASURED PRODUCTIVITY GROWTH FROM THIS SOURCE WOULD SHOW NO CHANGE IN FOUR YEARS OUT OF FIVE AND A PRODUCTIVITY INCREASE IN THE FIFTH YEAR THAT WAS ROUGHLY FIVE TIMES ITS LONG RUN ANNUAL RATE. OBVIOUSLY IF THIS SOURCE OF PRODUCTIVITY GROWTH WERE IMPORTANT, PRODUCTIVITY MEASUREMENT AVERAGED OVER LESS THAN A FIVE YEAR PERIOD WOULD YIELD A SERIOUS BIAS. IN FIGURE 2, ANNUAL GROWTH IN U.S. TFP IS COMPARED WITH 5 AND 10 YEAR MOVING AVERAGES, AND IT IS CLEAR THAT GROWTH ESTIMATES FROM ONE OR TWO YEARS CAN SERIOUSLY MISS-STATE THE LONG RUN AVERAGE TFP GROWTH AT ANY POINT IN TIME.

USING J. KENDRICK'S ESTIMATES OF U.S. TFP GROWTH

FROM 1884 TO 1969, THE PICTURE THAT EMERGES IS THAT THE VOLATILITY OF TFP GROWTH EXCEEDS THAT OF THE U.S. BUSINESS CYCLE, AND THAT THE AVERAGE FREQUENCY OF THE TFP GROWTH CYCLE OVER THIS PERIOD IS ABOUT 3 YEARS. THUS ANNUAL GROWTH IN TFP RISES AND FALLS MORE RAPIDLY THAN ANNUAL GROWTH IN GNP, AVERAGING ABOUT 3 YEARS BETWEEN PEAKS OR BETWEEN TROUGHS: SEE J.W. KENDRICK, LONG TERM ECONOMIC GROWTH 1860-1970, WASHINGTON D.C.: U.S. BUREAU OF THE CENSUS, JUNE 1973. FOR STATISTICAL PURPOSES, A 3 YEAR PERIOD (A COMPLETE CYCLE) SHOULD BE TREATED AS A SINGLE OBSERVATION, AND MULTIPLE 3 YEAR PERIODS--I.E., A MINIMUM OF 6 YEARS--MUST BE OBSERVED TO CALCULATE A MEANINGFUL AVERAGE PRODUCTIVITY MEASURE WITH ANY DEGREE OF PRECISION.

THE VOLATILITY OF ANNUAL TFP MEASURES IS GREATER FOR SMALLER AGGREGATES, SUCH AS FIRMS OR INDUSTRIES. FIGURE 3 SHOWS ANNUAL TFP GROWTH FOR THE TELECOMMUNICATIONS INDUSTRY, AS CALCULATED BY L.R. CHRISTENSEN (NORTH DAKOTA PUBLIC SERVICE COMMISSION CASE NO. PU-2320-90-149, OCTOBER 1, 1990). COMPARISON WITH FIGURE 2 SHOWS SIGNIFICANTLY GREATER VOLATILITY AT THE INDUSTRY LEVEL THAN FOR THE U.S. AS A WHOLE.

WHILE VOLATILITY OF PRODUCTIVITY GROWTH IS IMPORTANT, IT IS THE DIFFERENCE BETWEEN NATIONAL AND FIRM TFP GROWTH THAT MATTERS FOR THE PRODUCTIVITY TARGET IN THE FLORIDA PRICE REGULATION FORMULA. FIGURE 4 SHOWS CONSIDERABLE VARIATION IN ANNUAL PRODUCTIVITY DIFFERENCES, RANGING FROM +6.8 TO -5.6 PERCENT PER YEAR. THESE EXTREME DIFFERENCES ARE REDUCED TO A MAXIMUM OF +3.8 AND A MINIMUM OF 1.03 PERCENT USING A TEN-YEAR MOVING AVERAGE.

A SECOND PROBLEM WITH USING PRODUCTIVITY TARGETS ESTIMATED OVER A SHORT PERIOD OF TIME IS THAT THEY MUST BE FREQUENTLY REVISED TO AVOID BIAS. AS THE REVISIONS BECOME MORE FREQUENT, THE INCENTIVES UNDER THE PLAN BECOME CLOSER TO THOSE UNDER ORDINARY RATE OF RETURN REGULATION. FREQUENT REVISIONS OF THE PRODUCTIVITY TARGET WOULD EVISCERATE THE VERY INCENTIVES THE PLAN WAS DESIGNED TO CREATE.

Q. ON PAGES 45-47, DR. CHESSLER PROPOSES A PRODUCTIVITY TARGET OF 5.5 PERCENT BASED THE AVERAGE RATE OF INCREASE OF LABOR PRODUCTIVITY IN THE INDUSTRY BETWEEN 1960 AND 1977. IS IT CORRECT

TO USE LABOR PRODUCTIVITY TO CALCULATE A PRODUCTIVITY TARGET IN A PRICE CAP FORMULA?

A. NO. IT IS INAPPROPRIATE TO SET A TARGET IN A PRICE CAP PLAN BASED ON LABOR PRODUCTIVITY. ATTACHMENT 2 SHOWS THAT THE PRODUCTIVITY TARGET THAT GUARANTEES THAT PRICES CHANGE AT THE SAME RATE AS COSTS IF THE PRODUCTIVITY TARGET IS MET IS A TOTAL FACTOR PRODUCTIVITY TARGET. INDEED, THE CRANDALL VOLUME CITED BY DR. CHESSLER STATES THAT

> "A BETTER MEASURE OF PRODUCTIVITY GROWTH [THAN LABOR PRODUCTIVITY GROWTH] IS THE GROWTH IN TOTAL FACTOR PRODUCTIVITY," (P. 67).

HISTORICALLY, HIGH RATES OF LABOR PRODUCTIVITY HAVE BEEN OBSERVED IN THE TELEPHONE INDUSTRY DUE TO THE REPLACEMENT OF LABOR BY CAPITAL. THIS FACT IMPLIES THAT LABOR PRODUCTIVITY GROWTH WILL EXCEED TOTAL FACTOR PRODUCTIVITY GROWTH IN THE TELECOMMUNICATIONS INDUSTRY. DURING THE 1975-1988 PERIOD, CRANDALL FINDS THE GROWTH IN LABOR PRODUCTIVITY TO AVERAGE 5.8 PERCENT PER YEAR (NOT THE 5.58 PERCENT CITED BY DR. CHESSLER ON PAGE 46, LINE 1), COMPARED WITH A 3-FACTOR TOTAL FACTOR PRODUCTIVITY GROWTH OF 4.02 PERCENT PER YEAR (TABLE 3-14, P. 68). SINCE THE PRODUCTIVITY OFFSET SHOULD

BE BASED ON TOTAL FACTOR PRODUCTIVITY GROWTH, DR. CHESSLER'S RECOMMENDATION OF 5.5 PERCENT BASED ON HISTORICAL LABOR PRODUCTIVITY GROWTH WOULD TRANSLATE INTO A PRODUCTIVITY TARGET OF ABOUT 3.72 (= 5.5 - (5.8 - 4.02)) PERCENT BASED ON TOTAL FACTOR PRODUCTIVITY GROWTH. IN ADDITION, WE WOULD HAVE TO REMOVE THE ANNUAL RATE OF GROWTH OF U.S. TOTAL FACTOR PRODUCTIVITY (ABOUT 1 PERCENT FROM 1975-1988), LEAVING A PRODUCTIVITY TARGET IN THE NEIGHBORHOOD OF 2.7 PERCENT. THUS DR. CHESSLER'S PROPOSED PRODUCTIVITY TARGET--WHEN ADJUSTED FOR THE DIFFERENCE BETWEEN LABOR AND TOTAL FACTOR PRODUCTIVITY--IS SIGNIFICANTLY SMALLER THAN THE 4 PERCENT TARGET PROPOSED BY SOUTHERN BELL.

Q. DRS. CHESSLER AND KAHN BELIEVE AN APPROPRIATE PRODUCTIVITY TARGET FOR SOUTHERN BELL WOULD BE LARGER THAN 4 PERCENT. DO YOU AGREE?

A. NO. THE PRODUCTIVITY TARGET IN THE PRICE REGULATION PLAN REPRESENTS THE DIFFERENCE BETWEEN THE PRODUCTIVITY GROWTH OF THE REGULATED FIRM (OR INDUSTRY) AND THE U.S. RATE OF PRODUCTIVITY GROWTH THAT IS EMBEDDED IN THE GNP-PI. BASED ON RECENT LONG-RUN HISTORICAL EVIDENCE FROM MANY SOURCES AND

STUDIES, TELEPHONE TOTAL FACTOR PRODUCTIVITY GROWTH APPEARS TO EXCEED NATIONAL AVERAGE TOTAL FACTOR PRODUCTIVITY GROWTH BY ABOUT 2 PERCENTAGE POINTS PER YEAR. I SUMMARIZE THIS EVIDENCE IN ATTACHMENT 3.

BY THIS STANDARD, SOUTHERN BELL'S PROPOSED PRODUCTIVITY TARGET OF 4 PERCENT IS AMBITIOUS, AND THERE WOULD BE NO HISTORICAL PRECEDENT THAT COULD SUPPORT AN INDUSTRY PRODUCTIVITY TARGET ANYWHERE NEAR THE 5.5 TO 6 PERCENT TARGETS PROPOSED BY DRS. KAHN AND CHESSLER. FIGURE 5 HELPS US SEE WHY. FIGURE 5 SHOWS PRODUCTIVITY DIFFERENTIALS USING THE HISTORICAL 2 PERCENT PRODUCTIVITY DIFFERENTIAL DESCRIBED IN MY ATTACHMENT 3, THE 4 PERCENT TARGET PROPOSED BY SOUTHERN BELL, AND THE 6.1 PERCENT TARGET PROPOSED BY DR. KAHN, ALL RELATIVE TO ACTUAL TELEPHONE INDUSTRY PRICES (CPI-U TOTAL TELEPHONE PRICES). NOTICE THAT *GNP-PI - 2%* TRACKS REASONABLY CLOSELY THE CHANGES IN INDUSTRY PRICES OVER THE 1984-1992 TIME PERIOD. SINCE GNP-PI MEASURES THE CHANGE IN OUTPUT PRICES IN THE ECONOMY AS A WHOLE AND *GNP-PI - 2%* TRACKS TOTAL TELEPHONE PRICES, WE CONCLUDE THAT OVERALL PRICES FOR THE TELEPHONE INDUSTRY HAVE BEEN FALLING <u>IN REAL TERMS</u> ABOUT 2

PERCENT PER YEAR. IN OTHER WORDS, PRODUCTIVITY IN THE TELEPHONE INDUSTRY IS, ON AVERAGE, GROWING 2 PERCENT MORE RAPIDLY THAN IN THE U.S. ECONOMY OR TELEPHONE INDUSTRY EFFICIENCY HAS BROUGHT ABOUT A 2 PERCENT DECLINE IN REAL TELEPHONE INDUSTRY COSTS. SOUTHERN BELL PROPOSES TO INDEX ITS PRICES AT GNP-PI - 4%, AND FIGURE 5 SHOWS THAT WITH THAT TARGET, ITS PRICES WOULD HAVE GROWN SIGNIFICANTLY MORE SLOWLY THAN TELECOMMUNICATIONS INDUSTRY PRICES IN AGGREGATE. FINALLY, FIGURE 5 SHOWS THAT A TARGET OF 6.1 PERCENT, AS PROPOSED BY DR. KAHN, WOULD REQUIRE A MUCH FASTER RATE OF PRODUCTIVITY GROWTH THAN THAT ACHIEVED BY THE TELECOMMUNICATIONS INDUSTRY OVER THE 1984-1992 PERIOD.

IN FURTHER SUPPORT OF THE ADEQUACY OF A 4 PERCENT TARGET, RECALL THAT THE LONG-RUN HISTORICAL PRODUCTIVITY GROWTH IN THE TELECOMMUNICATIONS INDUSTRY INCLUDES PRODUCTIVITY GROWTH FOR BOTH LOCAL AND TOLL SERVICES. THE FACT THAT TOLL IS A RELATIVELY HIGH-MARGIN, RAPIDLY GROWING SERVICE IMPLIES THAT ITS PRODUCTIVITY GROWTH--ASSUMING EQUAL TECHNICAL CHANGE--SHOULD BE MORE RAPID THAN THAT OF LOCAL SERVICE. HENCE, ALL ELSE EQUAL, INTEREXCHANGE CARRIER PRODUCTIVITY GROWTH SHOULD

EXCEED THE INDUSTRY AVERAGE AND LOCAL EXCHANGE CARRIER PRODUCTIVITY GROWTH SHOULD FALL SHORT OF IT. SEE ATTACHMENT 3.

Q. DR. CHESSLER ASSERTS THAT AN APPROPRIATE PRODUCTIVITY OFFSET SHOULD BE "BASED ON STUDIES OF WHAT THE INDUSTRY HAS BEEN CAPABLE OF SUSTAINING OVER A LONG PERIOD OF TIME," (P. 83, LINES 9-10). DO YOU AGREE THAT THE PRODUCTIVITY OFFSET SHOULD BE BASED ON PAST PRODUCTIVITY GROWTH OF THE INDUSTRY RATHER THAN THE FIRM?

A. YES. IN PERFECTLY COMPETITIVE MARKETS, A FIRM'S PRICE IS DRIVEN TOWARDS ITS OWN MARGINAL COST, BUT INDUSTRY AVERAGE COSTS MATTER, TOO. IN THE LONG RUN, FIRMS WILL ENTER OR EXIT A COMPETITIVE MARKET UNTIL PRICE AND LONG RUN AVERAGE COST ARE APPROXIMATELY EQUAL AND THUS UNTIL AVERAGE EXCESS PROFITS ACROSS THE INDUSTRY ARE APPROXIMATELY ZERO.

IN A COMPETITIVE MARKET, FIRMS WILL REACT TO CHANGES IN AVERAGE COST BY CHANGING THEIR PRICES. IF LONG RUN AVERAGE COSTS RISE, THE AVERAGE INDUSTRY PRICE MUST EITHER RISE BY THE SAME AMOUNT OR FIRMS WILL EXPECT TO LOSE MONEY AND LEAVE THE

INDUSTRY. IF LONG RUN AVERAGE COST FALLS, PRICES WILL BE DRIVEN DOWNWARD BY THE SAME AMOUNT THROUGH COMPETITIVE ENTRY UNTIL AVERAGE EXCESS PROFIT IN THE INDUSTRY IS REDUCED TO ZERO. IN BOTH CASES, THE FORCES OF COMPETITION REQUIRE AVERAGE INDUSTRY PRICES TO FOLLOW COSTS, OR--EQUIVALENTLY--REQUIRE AVERAGE PRICES TO MOVE SO AS TO MAINTAIN AVERAGE EXCESS PROFITS OF ZERO IN THE INDUSTRY. IN THIS RESPECT, ADJUSTING THE REGULATED FIRM'S PRICE TO REFLECT CHANGES IN THE LONG RUN AVERAGE COST IN THE INDUSTRY EMULATES THE WORKINGS OF A COMPETITIVE MARKET.

ALL FIRMS IN A COMPETITIVE MARKET DO NOT EARN PRECISELY ZERO EXCESS PROFITS. THOSE FIRMS WITH HIGHER THAN AVERAGE PRODUCTIVITY GAINS CAN SET PRICE EQUAL TO THE INDUSTRY AVERAGE PRICE AND EARN EXCESS PROFITS, WHILE FIRMS ACHIEVING LOWER THAN AVERAGE PRODUCTIVITY GAINS WILL BE FORCED TO PRICE BELOW COST AND EXPERIENCE LOSSES. THIS FEATURE OF COMPETITIVE MARKETS PROVIDES FIRMS WITH AN INCENTIVE TO ACHIEVE ABOVE AVERAGE PRODUCTIVITY GROWTH. THE ABSENCE OF THIS INCENTIVE IS ONE OF THE SERIOUS DRAWBACKS OF RATE-OF-RETURN-BASED REGULATION IN FLORIDA, AND PRESERVING THIS

INCENTIVE IS A CRITICAL FEATURE OF THE PROPOSED PRICE REGULATION PLAN.

Q. ON PAGE 3 (LINES 1-3), DR. CORNELL OBJECTS TO ANY PLAN "THAT HAS ANY AUTOMATIC RATE INCREASE MECHANISM, AS TELECOMMUNICATIONS IS AN INDUSTRY IN WHICH COSTS ARE FALLING RATHER THAN RISING." DO YOU AGREE?

A. NO. TELECOMMUNICATIONS IS A DECLINING COST INDUSTRY IN THE SENSE THAT, HISTORICALLY, ITS PRODUCTIVITY GROWTH HAS EXCEEDED THE NATIONAL AVERAGE PRODUCTIVITY GROWTH BY ABOUT TWO PERCENT PER YEAR (SEE ATTACHMENT 3). IN TURN, THIS PRODUCTIVITY GROWTH HAS PERMITTED PRICES FOR THE AGGREGATE OF TELECOMMUNICATIONS SERVICES TO RISE ABOUT 2 PERCENTAGE POINTS PER YEAR MORE SLOWLY THAN INFLATION. THUS, BASED ON HISTORICAL PERFORMANCE, TELECOMMUNICATIONS COSTS AND PRICES HAVE RISEN--NOT FALLEN--BUT RISEN AT A SLOWER RATE THAN PRICES IN GENERAL.

THE PROPOSED PRICE CAP ADJUSTMENT FOR FLORIDA IS A GOOD DEAL FOR CUSTOMERS FROM THIS HISTORICAL PERSPECTIVE BECAUSE IT REQUIRES THAT SOUTHERN

BELL'S PRICES GROW NO FASTER THAN 4 PERCENTAGE POINTS MORE SLOWLY THAN INFLATION. WHETHER OR NOT THE PROPOSED PRICE CAP GOES UP OR DOWN DEPENDS ON WHETHER INFLATION EXCEEDS 4 PERCENT, BUT IN EITHER CASE, THE FLORIDA CUSTOMER WILL EXPERIENCE LOWER PRICE CHANGES THAN THE TELECOMMUNICATIONS INDUSTRY HAS EXPERIENCED IN THE PAST.

Q. MR. GUEDEL ARGUES THAT PRICE CAP REGULATION IS INAPPROPRIATE FOR SOUTHERN BELL BECAUSE TOLL DEMAND STIMULATION INCREASES ITS CARRIER COMMON LINE REVENUE WITHOUT INCREASING THE NON-TRAFFIC SENSITIVE COSTS THAT THE CARRIER COMMON LINE CHARGE IS SUPPOSED TO RECOVER (P. 4-16). DO YOU AGREE WITH THIS CONCLUSION?

A. NO. THE HISTORICAL PRODUCTIVITY TARGET IS BASED ON THE EXPERIENCE OF THE ENTIRE FIRM OR INDUSTRY OVER A LONG PERIOD OF TIME. THE AVERAGE EFFECT OF TOLL DEMAND STIMULATION ON MEASURED PRODUCTIVITY IS THUS INCLUDED IN THE DATA USED TO SET THE TARGET. WHILE THE EFFECT OF DEMAND GROWTH ON CARRIER COMMON LINE REVENUE MAY APPEAR TO BE A WINDFALL FOR SOUTHERN BELL, (1) IT IS PRESENT IN THE HISTORICAL ANALYSIS USED TO SET THE TARGET, AND (2) THE EFFECT IS

SYMMETRIC. IF, FOR EXAMPLE, THE AT&T NETWORK FAILS, SOUTHERN BELL ACCESS DEMAND IS REDUCED--THROUGH NO FAULT OF ITS OWN--SO THAT ITS CARRIER COMMON LINE REVENUES FALL WITH NO REDUCTION IN ITS NON-TRAFFIC SENSITIVE COSTS.

THUS INCLUDING CARRIER COMMON LINE REVENUES IN THE PRICE CAP DOES NOT CONFER A WINDFALL ON SOUTHERN BELL.

IV. COSTS, CROSS-SUBSIDIZATION AND PRICE SQUEEZES

Q. DR. CORNELL CLAIMS THAT AN INCREMENTAL COST-BASED PRICE FLOOR "WOULD ALLOW SOUTHERN BELL TO MONOPOLIZE A MARKET EVEN WHEN IT WAS NOT THE MOST EFFICIENT SUPPLIER OF THE SERVICE IN QUESTION" (PAGE 14, LINES 16-18) BECAUSE (1) SOME ECONOMIC COSTS WOULD BE TREATED AS SUNK COSTS, AND (2) THE PRICE FLOOR WOULD BE SET AT MARGINAL COST, NOT TOTAL SERVICE INCREMENTAL COST. DO YOU AGREE?

A. NO. FIRST, SUNK COSTS ARE NOT PROPERLY PART OF ANY LONG RUN INCREMENTAL COST STUDY. ONLY COSTS THAT CHANGE IN THE FUTURE BASED ON SOME CURRENT DECISION ARE PART OF THE LONG RUN INCREMENTAL COST OF THAT DECISION. THUS DR. CORNELL'S STATEMENT THAT "TRULY

LONG RUN INCREMENTAL COSTS DO NOT TREAT AS SUNK ANY COST THAT THE COMPANY WOULD INCUR IF IT WERE CONSTRUCTING ITS NETWORK TODAY" (P. 14, LINES 9-10, EMPHASIS IN ORIGINAL) IS INCORRECT. LONG RUN INCREMENTAL COSTS MEASURE THE COST OF ADAPTING THE CURRENT NETWORK--OVER A SUFFICIENTLY LONG PERIOD THAT ALL INPUTS ARE VARIABLE--TO SERVE THE ADDITIONAL INCREMENT OF DEMAND. THEY ARE NOT THE COSTS INCURRED IF A NEW NETWORK WERE CONSTRUCTED FROM SCRATCH. FOR CONSUMERS TO RECEIVE PROPER PRICING SIGNALS, PRICES MUST BE SET WITH REGARD TO THE ACTUAL COSTS THAT ADDITIONAL CONSUMPTION WOULD CAUSE THE NETWORK TO INCUR.

SECOND, DR. CORNELL PROPOSES THE WRONG COST STANDARD TO USE AS A FLOOR FOR PRICING COMPETITIVE SERVICES. IN GENERAL, AVERAGE INCREMENTAL COST IS DEFINED AS THE CHANGE IN TOTAL COST DIVIDED BY THE CHANGE IN OUTPUT (THE INCREMENT) THAT CAUSED THE CHANGE IN TOTAL COST. FOR A SMALL INCREMENT, AVERAGE INCREMENTAL COST IS CALLED "MARGINAL COST," AND LONG RUN MARGINAL COST IS THE APPROPRIATE FLOOR FOR PRICING. WHEN THE INCREMENT OF DEMAND IS THE ENTIRE SERVICE, AVERAGE INCREMENTAL COST IS CALLED "TOTAL SERVICE (OR SERVICE) INCREMENTAL COST," AND

LONG RUN TOTAL SERVICE INCREMENTAL COST IS THE APPROPRIATE COST STANDARD TO DETERMINE IF IT IS PROFITABLE FOR A FIRM TO ENTER OR LEAVE A MARKET OR TO TEST WHETHER A SERVICE IS RECEIVING A SUBSIDY. A PRICE FLOOR ABOVE MARGINAL COST IS INEFFICIENT BECAUSE IT DISCOURAGES CONSUMPTION FOR WHICH THE VALUE OF ADDITIONAL SERVICE TO THE CUSTOMER EXCEEDS THE ADDITIONAL COST OF PROVIDING THAT SERVICE.

THE ROLE THAT TOTAL SERVICE INCREMENTAL COST PLAYS IN ECONOMICS IS AS A TEST FOR CROSS-SUBSIDIZATION. IF THE FIRM DOES NOT RECOVER IN REVENUES AT LEAST THE FORWARD-LOOKING TOTAL SERVICE INCREMENTAL COST OF SERVICE, THE FIRM WILL FIND IT MORE PROFITABLE TO LEAVE THE MARKET RATHER THAN PRODUCE ANY NON-ZERO AMOUNT OF OUTPUT. IF A REGULATED FIRM EARNS ITS ALLOWED RATE OF RETURN AND REMAINS IN THE MARKET UNDER THIS CIRCUMSTANCE, IT IS CROSS-SUBSIDIZING THE SERVICE, IN THE SENSE THAT PRICES FOR SOME OTHER SERVICE MUST NECESSARILY BE HIGHER BECAUSE THE FIRM REMAINS IN THE SUBSIDIZED MARKET.

Q. TO SAFEGUARD AGAINST CROSS-SUBSIDY, DR. CORNELL RECOMMENDS THAT THE PRICE FLOOR BE THE HIGHER OF THE TOTAL SERVICE INCREMENTAL COST OF PROVIDING THE

ENTIRE SERVICE OR MARGINAL COST (P. 14, LINES 3-5). DOES SUCH A PRICE FLOOR MAKE GOOD ECONOMIC SENSE?

A. NO. SUPPOSE (1) THE SERVICE IN QUESTION IS ONE THAT THE COMMISSION DOES NOT WANT THE REGULATED FIRM TO SUBSIDIZE, AND (2) THE TOTAL SERVICE INCREMENTAL COST OF THE SERVICE EXCEEDS ITS MARGINAL COST. A PRICE FLOOR AT TOTAL SERVICE INCREMENTAL COST WOULD BE INEFFICIENT. THE REGULATED FIRM COULD RECOVER MORE CONTRIBUTION FROM THE SERVICE BY PRICING SOME UNITS BELOW TOTAL SERVICE INCREMENTAL COSTS AND SOME ABOVE. SUCH PRICING IS COMMON IN UNREGULATED MARKETS, WHERE FIRMS OFFER VOLUME DISCOUNTS, OFF-PEAK DISCOUNTS, OR DISCOUNTS TO PARTICULAR CLASSES OF CUSTOMERS. AS LONG AS EACH OF THE DISCOUNTED PRICES EXCEEDS MARGINAL COST, THE PRICE IS NOT ANTICOMPETITIVE. AS LONG AS THE TOTAL REVENUE FROM PROVIDING THE SERVICE EXCEEDS THE TOTAL INCREMENTAL COST OF PROVIDING THE SERVICE, THE SERVICE IS NOT BEING CROSS-SUBSIDIZED. THE PRICE FLOOR FOR EACH AND EVERY UNIT OF SERVICE SUGGESTED BY DR. CORNELL WOULD INEFFICIENTLY HANDICAP THE REGULATED FIRM IN THE MARKETS IN WHICH IT FACES COMPETITION AND IS UNNECESSARY TO PREVENT CROSS-SUBSIDIZATION.

Q. DR. CORNELL CLAIMS THAT THE TOTAL SERVICE INCREMENTAL COST OF THE ENTIRE SERVICE IS THE APPROPRIATE MEASURE OF COST TO TEST WHETHER A SERVICE (OR GROUP OF SERVICES) IS BEING SUBSIDIZED (P. 14, LINES 21-22). IS THAT A CORRECT STATEMENT OF ECONOMIC THEORY?

A. YES. IN ECONOMIC THEORY, A SERVICE IS GENERALLY SAID TO BE SUBSIDIZED IF IT IS PRICED LESS THAN THE TOTAL SERVICE INCREMENTAL COST OF THE ENTIRE SERVICE AND A GROUP OF SERVICES IS SAID TO BE SUBSIDIZED IF, TOGETHER, THEIR INCREMENTAL REVENUE DOES NOT COVER THE TOTAL SERVICE INCREMENTAL COST OF THE GROUP (SEE, E.G., G.R. FAULHABER, "CROSS-SUBSIDIZATION: PRICING IN PUBLIC ENTERPRISES," THE AMERICAN ECONOMIC REVIEW, VOL. 65, NO. 5, DECEMBER, 1975, PP. 966-977, OR W.J. BAUMOL, "MINIMUM AND MAXIMUM PRICING PRINCIPLES FOR RESIDUAL REGULATION," EASTERN ECONOMIC JOURNAL, VOL V, NO 1-2, JANUARY/APRIL 1979, PP. 235-248).

Q. ON PAGES 14 (LINES 2-5), DR. CORNELL RECOMMENDS THAT THE HIGHER OF MARGINAL COST AND THE AVERAGE INCREMENTAL COST OF THE ENTIRE SERVICE BE USED AS THE FLOOR FOR COMPETITIVE SERVICES PRICES. DO YOU

RECOMMEND CALCULATING THE AVERAGE INCREMENTAL COST OF THE ENTIRE SERVICE--WHAT WE HAVE CALLED "TOTAL SERVICE INCREMENTAL COST"--AS A WAY TO PREVENT CROSS-SUBSIDIZATION IN FLORIDA?

A. NO, THERE ARE SEVERAL PROBLEMS IN THE APPLICATION OF THE CONCEPT OF TOTAL SERVICE INCREMENTAL COST AS A TEST OF CROSS-SUBSIDIZATION. FIRST, AS A PRACTICAL MATTER, THERE IS NO NEED TO DO SUCH TESTS ROUTINELY. IN ECONOMIC THEORY, SOUTHERN BELL HAS NO INCENTIVE TO SUBSIDIZE A COMPETITIVE SERVICE. IF ITS PRICE IS SET BELOW ITS FORWARD-LOOKING TOTAL SERVICE INCREMENTAL COST, THE FIRM WOULD EARN LESS MONEY THAN IT WOULD EARN IF IT LEFT THE MARKET. REMAINING IN THE MARKET AT SUCH A LOW PRICE COULD BE PROFITABLE ONLY IF THE FIRM COULD THEREBY DRIVE ITS RIVALS OUT OF THE MARKET, ERECT BARRIERS TO ENTRY TO KEEP THEM OUT OF THE MARKET, AND LATER RAISE PRICES TO EARN SUFFICIENT MONOPOLY PROFITS TO RECOUP ITS EARLIER LOSSES. THIS SEQUENCE OF EVENTS IS HIGHLY UNLIKELY FOR TELECOMMUNICATIONS MARKETS IN FLORIDA. IRRESPECTIVE OF SOUTHERN BELL'S INTRASTATE TOLL PRICES, ITS MAJOR COMPETITORS WILL CONTINUE TO PROVIDE INTERSTATE TOLL SERVICES IN FLORIDA AND IN EVERY OTHER STATE IN THE U.S. HENCE

SOUTHERN BELL COULD NOT REASONABLY EXPECT TO BE ABLE TO RAISE INTRASTATE TOLL PRICES IN FLORIDA TO MONOPOLY LEVELS AT SOME LATER TIME TO MAKE UP FOR ITS LOSSES TODAY.

SECOND, AS DISCUSSED ABOVE, THE PROPER PRICE FLOOR FOR EACH SERVICE SHOULD STILL BE MARGINAL COST. SUPPOSE A GROUP OF USAGE SERVICES (E.G., MTS, 800 SERVICE, AND OPTIONAL CALLING PLANS FOR SWITCHED SERVICE) HAPPENED TO SHARE A FACILITY WHOSE COSTS WERE FIXED (E.G., A SOFTWARE UPGRADE TO A SWITCH THAT EACH USAGE SERVICE REQUIRED). SUPPOSE FURTHER THAT THIS FIXED COST WAS NOT SUNK, SO THAT SOUTHERN BELL WOULD NOT INCUR THIS FIXED COST IF IT LEFT ALL SWITCHED SERVICE MARKETS. THEN ALL SWITCHED SERVICES TOGETHER SHOULD BE PRICED TO COVER THE COST OF THE SOFTWARE, BUT THE EFFICIENT PRICE FLOOR FOR ANY INDIVIDUAL SERVICE REMAINS THE CONVENTIONAL MEASURE OF INCREMENTAL COST FOR THAT SERVICE. SOUTHERN BELL MUST PRICE SOME OF THE SERVICES ABOVE THEIR (CONVENTIONAL) MARGINAL COSTS TO COVER THE FIXED COMMON COST OF THE SOFTWARE, BUT IT IS INCORRECT TO ASSIGN THAT COST TO SERVICES ON A MINUTE-OF-USE, REVENUE, EQUAL PROPORTION, OR OTHER ARBITRARY BASIS. CONCERN ABOUT CROSS-SUBSIDIZATION

OF USAGE SERVICES AS A GROUP SHOULD NOT BE USED TO INTRODUCE A FORM OF FULLY-DISTRIBUTED COST-BASED PRICING.

FINALLY, REQUIRING A SERVICE INCREMENTAL COST TEST FOR CROSS-SUBSIDY IN FLORIDA IS A BIT LIKE REQUIRING A DELICATESSEN'S SCALES TO COMPENSATE FOR THE GRAVITATIONAL PULL OF THE MOON. SUBSIDIZATION, IF IT EXISTS, IS FAR MORE LIKELY TO FLOW FROM COMPETITIVE SERVICES (SUCH AS TOLL) TO NON-COMPETITIVE SERVICES (SUCH AS RESIDENTIAL ACCESS SERVICE). TOLL RATES ARE CURRENTLY SET AT MANY MULTIPLES OF INCREMENTAL COST WHILE LOCAL ACCESS RATES ARE SET AT OR BELOW INCREMENTAL COST.

Q. MR. CRESSE PROPOSES THAT CROSS-SUBSIDIZATION BE PREVENTED BY REQUIRING THE PRICE OF EACH COMPETITIVE SERVICE TO EXCEED ITS COST, WHERE ITS COST INCLUDES "A PRO RATA ALLOCATION OF OVERHEAD AND ADMINISTRATIVE EXPENSE" (P. 23, LINES 7-8). IS THIS A PROPER COST TEST FOR CROSS-SUBSIDIZATION?

A. NO. FULLY DISTRIBUTED COSTS ARE NOT AN APPROPRIATE FOUNDATION FOR DETECTING WHAT ECONOMISTS MEAN BY CROSS-SUBSIDIZATION. IF THE FULLY-DISTRIBUTED COST

OF A COMPETITIVE SERVICE EXCEEDED ITS TOTAL SERVICE INCREMENTAL COST, MR. CRESSE'S TEST WOULD MISTAKENLY FIND CROSS-SUBSIDIES WHERE NO SUBSIDY--IN AN ECONOMIC SENSE--WAS TAKING PLACE. IN SUCH CASES, SINCE NO ECONOMIC CROSS-SUBSIDY IS TAKING PLACE, ALL CUSTOMERS OF THE REGULATED FIRM (CUSTOMERS OF BOTH MONOPOLY AND COMPETITIVE SERVICES) ARE BETTER OFF BECAUSE THE FIRM PROVIDES THE COMPETITIVE SERVICE. THE REASON IS SIMPLE. AS LONG AS THE REVENUE FROM THE COMPETITIVE SERVICE EXCEEDS THE ADDITIONAL COST INCURRED TO PROVIDE THE (ENTIRE) SERVICE, THE SERVICE IS MAKING A POSITIVE CONTRIBUTION TO THE COMMON COSTS OF THE FIRM. IT MAY NOT MAKE AS MUCH CONTRIBUTION AS WOULD BE DEEMED FAIR BY AN ARBITRARY ALLOCATION PROCESS, BUT AS LONG AS IT MAKES POSITIVE CONTRIBUTION, ALL CUSTOMERS OF THE FIRM ARE BETTER OFF BECAUSE THE SERVICE IS PROVIDED. USE OF MR. CRESSE'S TEST MIGHT MAKE THE REGULATED FIRM'S COMPETITORS BETTER OFF, BUT IT WOULD MAKE ALL RATEPAYERS WORSE OFF.

Q. ON PAGES 20-21, MR. CRESSE DISTINGUISHES BETWEEN THE "MOST COST EFFECTIVE" PROVISION OF A MONOPOLY SERVICE FROM THE "MOST ECONOMIC" PROVISION OF THE SERVICE, WHERE "COST-EFFECTIVE" APPEARS TO MEAN

"LEAST COST FOR THE RATEPAYER" WHILE "MOST ECONOMIC" APPEARS TO TAKE INTO ACCOUNT COSTS AND REVENUES FOR OTHER SERVICES. HOW DOES AN ECONOMIST APPROACH THIS DISTINCTION?

A. IN ECONOMIC THEORY, THE MARGINAL COST OF A SERVICE SHOULD BE MEASURED AS THE COST OF EXPANDING OUTPUT IN A NETWORK DESIGNED TO MAXIMIZE BENEFITS TO ALL SUBSCRIBERS COLLECTIVELY. SUPPOSE THERE ARE TWO SERVICES, PLAIN OLD TELEPHONE SERVICE (POTS) AND TOLL. THE TOTAL SERVICE INCREMENTAL COST OF TOLL IS THE DIFFERENCE BETWEEN THE TOTAL COST OF PROVIDING BOTH TOLL AND POTS LESS THE TOTAL COST OF PROVIDING POTS ALONE, WHERE COSTS ARE MEASURED ON A FORWARD-LOOKING BASIS. THESE TOTAL COSTS WOULD NOT BE MEASURED IN DIFFERENT NETWORKS, ONE OPTIMALLY DESIGNED TO SUPPLY POTS AND THE OTHER DESIGNED TO SUPPLY BOTH POTS AND TOLL. RATHER, IF A LOCAL EXCHANGE CARRIER TODAY CEASED TO PROVIDE TOLL, THE MINIMUM TOTAL COST OF PROVIDING THE REMAINING LOCAL SERVICE WOULD BE MEASURED WITH THE CURRENT NETWORK AS A STARTING POINT. COMPARISON WITH AN OPTIMALLY DESIGNED, SPECIALIZED, POTS-ONLY NETWORK IS NOT THE PROPER COMPARISON IN THE TOTAL SERVICE INCREMENTAL COST CALCULATION. IT WOULD BE FAR TOO EXPENSIVE TO

SCRAP THE EXISTING NETWORK--ENGINEERED AS IT MAY HAVE BEEN TO PROVIDE MULTIPLE SERVICES--AND REBUILD A DIFFERENT NETWORK TO SERVE ONLY LOCAL DEMAND. THUS, ON A FORWARD-LOOKING BASIS, THE TOTAL SERVICE INCREMENTAL COST OF TOLL SERVICES WOULD COVER ONLY THOSE COSTS WHICH WOULD CHANGE IN THE FUTURE IF TOLL WERE DISCONTINUED. MOREOVER, PRICES FOR TOLL SHOULD REFLECT THE MARGINAL COST OF TOLL SERVICE, MEASURED IN THE EXISTING NETWORK THAT SERVICES BOTH TOLL AND POTS CUSTOMERS.

AN EXAMPLE MAY HELP. SUPPOSE WE HAVE AN IDIOSYNCRATIC CONSUMER OF BUMPERLESS CARS WHO, TO SATISFY HIS SIMPLE NEEDS, MUST PAY FOR A CAR CONTAINING BUMPERS AND PAY MORE TO HAVE THOSE BUMPERS REMOVED. CONSIDER THE TOTAL SERVICE INCREMENTAL COSTS OF ORDINARY AND BUMPERLESS AUTOMOBILES. THE INCORRECT METHOD WOULD BE TO COMPARE THE MINIMUM TOTAL COST OF PROVIDING BOTH BUMPERLESS AND ORDINARY CARS WITH THE MINIMUM TOTAL COST OF PRODUCING EITHER TYPE OF CAR BY ITSELF IN A SPECIALIZED FACTORY. BY THIS STANDARD, THE TOTAL SERVICE INCREMENTAL COST OF A BUMPERLESS CAR WOULD BE LESS THAN THAT OF AN ORDINARY CAR, BUT IN THE COMPETITIVE AUTOMOBILE MARKET, THE ORDINARY CAR

WOULD BE CHEAPER.

IN SUM, THE DIFFERENCE IN COST STANDARDS IS THAT ECONOMISTS MEASURE THE COST CONSEQUENCES OF A CHANGE IN DEMAND STARTING FROM THE CURRENT NETWORK WHILE MR. CRESSE COMPARES COSTS IN SPECIALIZED NETWORKS FULLY OPTIMIZED TO PROVIDE ONE OR BOTH SERVICES. ECONOMIC THEORY DOES NOT SUPPORT THE USE OF THE LATTER COSTS FOR PRICING BECAUSE IT WOULD NEVER BE EFFICIENT TO SCRAP AND REBUILD THE NETWORK FROM SCRATCH TO SERVE ADDITIONAL DEMAND.

Q. MR. CRESSE (P. 20, LINE 12) ASSERTS THAT "SOUTHERN BELL'S BASIC TELEPHONE SERVICE RATES (SHOULD) BE BASED IN THE MOST COST EFFECTIVE MEANS OF PROVIDING BASIC TELEPHONE SERVICE." DO YOU AGREE?

A. NO. PRICES FOR SERVICES SHOULD REFLECT THE INCREMENTAL COSTS ASSOCIATED WITH PROVIDING A FEW MORE (OR A FEW LESS) UNITS OF THE SERVICE SO THAT CUSTOMERS PAY FOR THE COSTS THEY ACTUALLY CAUSE. INCREASED OR DECREASED CONSUMER DEMAND CAUSES COSTS TO CHANGE IN THE EXISTING NETWORK, NOT IN A HYPOTHETICAL NETWORK ENGINEERED TO PROVIDE A DIFFERENT MIX OF SERVICES. IF THE NETWORK HAS BEEN

ENGINEERED TO PROVIDE MAXIMUM BENEFIT TO ALL SUBSCRIBERS COLLECTIVELY, THEN THE MARGINAL COST OF BASIC TELEPHONE SERVICE IN THAT NETWORK IS THE APPROPRIATE BASIS FOR SETTING THE PRICE OF BASIC TELEPHONE SERVICE.

Q. DR. CORNELL RECOMMENDS THAT "A BUILDING BLOCK APPROACH TO COSTING AND TO SETTING PRICE FLOORS" (P. 3, LINES 7-8) BE IMPLEMENTED BEFORE SOUTHERN BELL IS GRANTED PRICING FLEXIBILITY. SHOULD THE COSTS OF INDIVIDUAL NETWORK FUNCTIONS BE USED TO CONSTRAIN THE PRICES OF THE REGULATED FIRM?

A. NO. FOR CALCULATING INCREMENTAL COSTS FOR A SERVICE, IT IS STANDARD PRACTICE TO IDENTIFY THE BASIC NETWORK FUNCTIONS THAT THE SERVICE REQUIRES AND CALCULATE THE INCREMENTAL COST FOR THE SERVICE FROM THE INCREMENTAL COSTS OF THE BASIC NETWORK FUNCTIONS. HOWEVER, THE COST FOR EACH BUILDING BLOCK CAN DEPEND ON THE SERVICE IN WHICH IT IS EMBEDDED. ECONOMIES OF SCALE CAN REDUCE THE COST OF PROVIDING LOOPS TO A SINGLE CUSTOMER'S PREMISE, AND ECONOMIES OF SCOPE CAN REDUCE THE COST OF PROVIDING TWO SWITCHING FUNCTIONS TOGETHER IN THE SAME SERVICE. COSTS CONSTRUCTED MECHANICALLY FROM

BUILDING BLOCKS IGNORE THESE EFFECTS. WORSE STILL, THE BUILDING BLOCKS APPROACH APPEARS TO ALLOCATE VOLUME-INSENSITIVE COSTS THAT ARE COMMON TO SEVERAL SERVICES TO THOSE SERVICES BASED ON RELATIVE USE. ECONOMIC MEASURES OF INCREMENTAL COST DO NOT ALLOCATE VOLUME-INSENSITIVE COSTS OF ANY DESCRIPTION BY ANY METHOD. FINALLY, AS DISCUSSED ABOVE, THE APPROPRIATE PRICE FLOOR FOR COMPETITIVE SERVICES IS MARGINAL COST, NOT TOTAL SERVICE INCREMENTAL COST. IN PARTICULAR, ANY BUILDING-BLOCK MEASURE OF TOTAL SERVICE INCREMENTAL COST IN WHICH FIXED COSTS, COMMON TO SEVERAL SERVICES, ARE ALLOCATED TO THE SERVICES IN QUESTION IS NOT APPROPRIATE.

Q. DR. CORNELL CRITICIZES THE PROPOSED PRICE REGULATION PLAN BECAUSE "NOWHERE IN SOUTHERN BELL'S PLAN IS THERE ANY SET OF SAFEGUARDS TO PREVENT IT FROM IMPOSING A PRICE SQUEEZE ON ITS DEPENDENT COMPETITORS" (P. 10, LINES 25-26). SHE RECOMMENDS THAT "IMPUTATION OF THE CHARGES TO DEPENDENT COMPETITORS...BE REQUIRED FOR EACH AND EVERY SERVICE THAT FACES ENTRY" (P. 19, LINES 5-6). IS THIS A VALID CRITICISM OF THE PLAN?

A. NO, FOLLOWING ITS OWN SELF-INTEREST, SOUTHERN BELL HAS AN INCENTIVE TO PRICE ITS COMPETITIVE SERVICES SO AS TO AVOID A PRICE SQUEEZE. OTHERWISE, THE COMPANY WOULD FOREGO PROFITS THAT IT COULD OTHERWISE EARN BY PROVIDING ACCESS SERVICES TO ITS DEPENDENT COMPETITORS.

SUPPOSE THAT TOLL IS THE COMPETITIVE SERVICE AND THAT INTEREXCHANGE CARRIERS MUST PURCHASE SOME TYPE OF SOUTHERN BELL'S CARRIER ACCESS SERVICE TO SERVE AT LEAST SOME CUSTOMERS. THEN SOUTHERN BELL WILL EITHER PROVIDE ACCESS SERVICE TO AN INTEREXCHANGE CARRIER, OR IT WILL PROVIDE TOLL SERVICE DIRECTLY TO ITS TOLL CUSTOMERS. SUPPOSE SOUTHERN BELL WANTS TO SET PRICES FOR CARRIER ACCESS AND FOR TOLL SERVICE SO THAT ITS PROFIT IS AS LARGE AS POSSIBLE. ECONOMIC THEORY TELLS US THAT THE PROFIT-MAXIMIZING PRICE FOR TOLL SERVICE MUST ACCOUNT FOR BOTH THE INCREMENTAL COST THE COMPANY INCURS TO PROVIDE TOLL SERVICE AS WELL AS THE NET REVENUE (REVENUE LESS INCREMENTAL COST) IT WOULD HAVE RECEIVED FROM PROVIDING CARRIER ACCESS SERVICE TO AN INTEREXCHANGE CARRIER. THE PROFIT-MAXIMIZING PRICE FOR SOUTHERN BELL'S TOLL SERVICE CAN BE NO LESS THAN THE MARGINAL COST OF TOLL PLUS THE DIFFERENCE

BETWEEN THE REVENUE AND COST FROM PROVIDING CARRIER ACCESS SERVICE TO THE INTEREXCHANGE CARRIER. OTHERWISE, SOUTHERN BELL WOULD MAKE MORE MONEY BY SELLING CARRIER ACCESS THAN BY SELLING TOLL. THIS CALCULATION DEMONSTRATES THAT SOUTHERN BELL HAS NO FINANCIAL INCENTIVE TO ENGAGE IN A PRICE SQUEEZE.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. YES.

Figure 1
The Productivity Offset for Southern Bell
Implied by Exhibit MHK 4-1

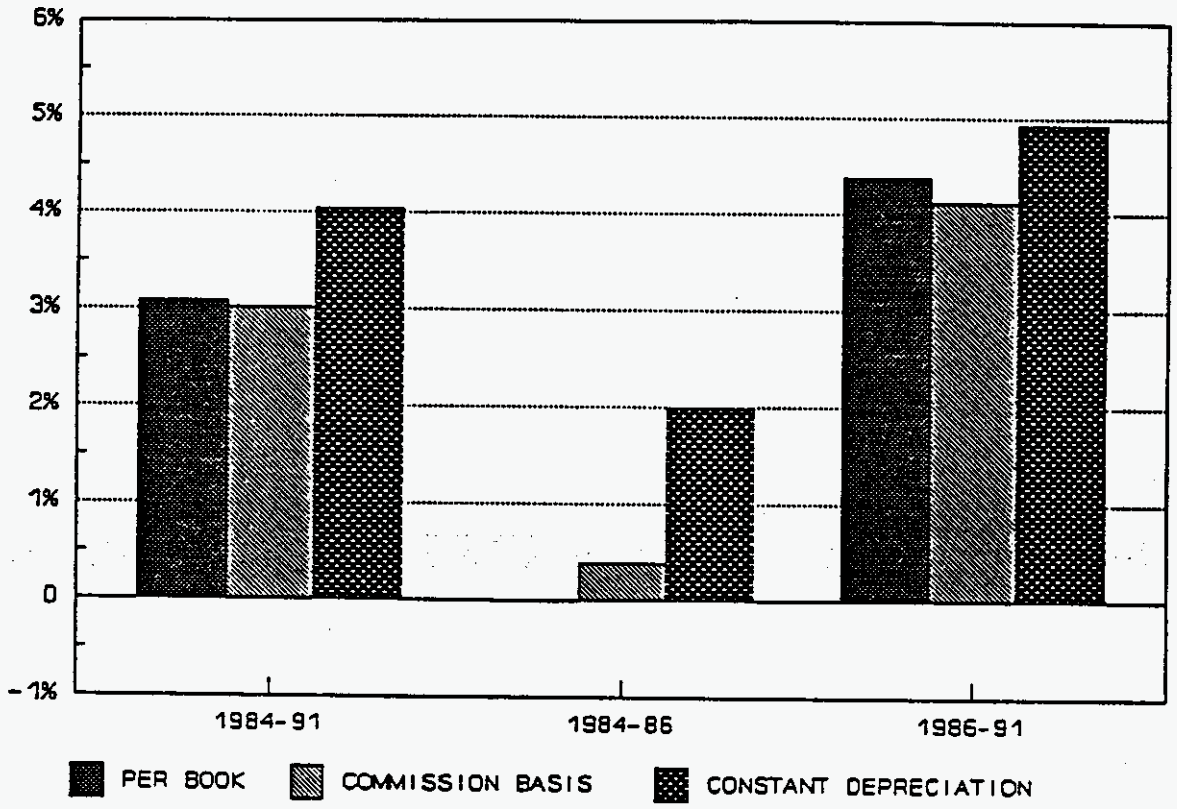


Figure 2
U.S. Private Business TFP Growth

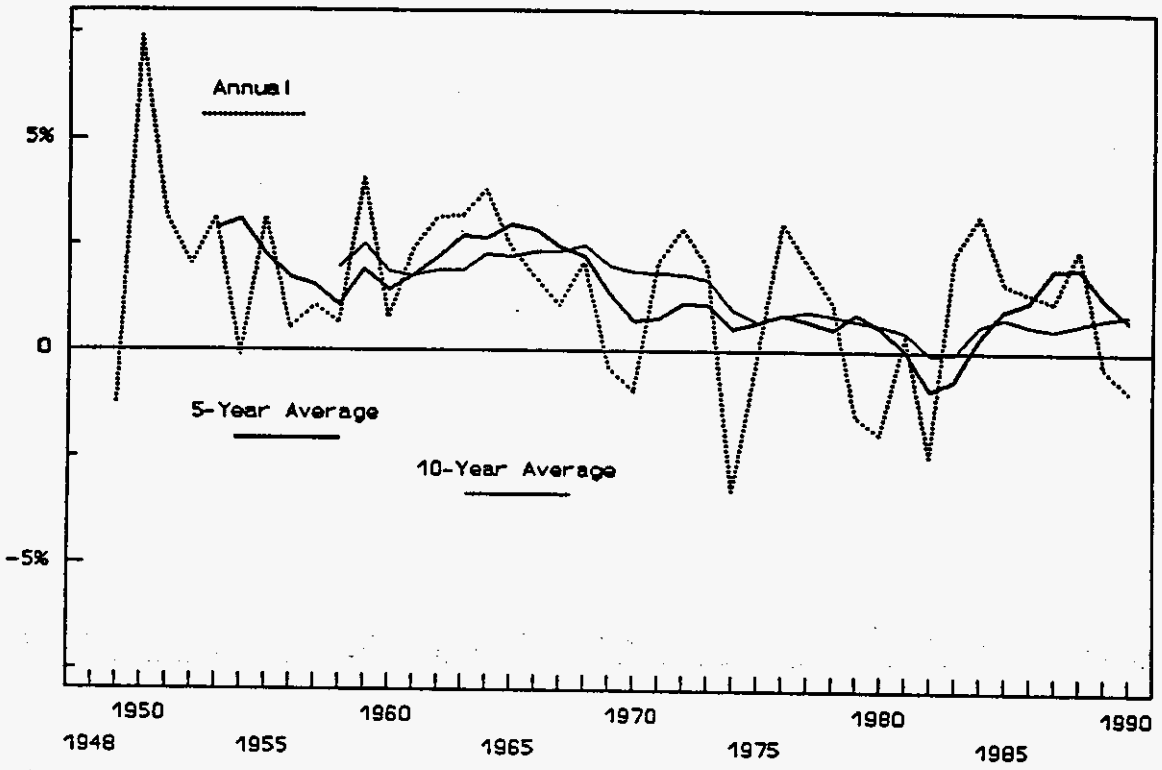


Figure 3
Telecommunications Industry TFP Growth

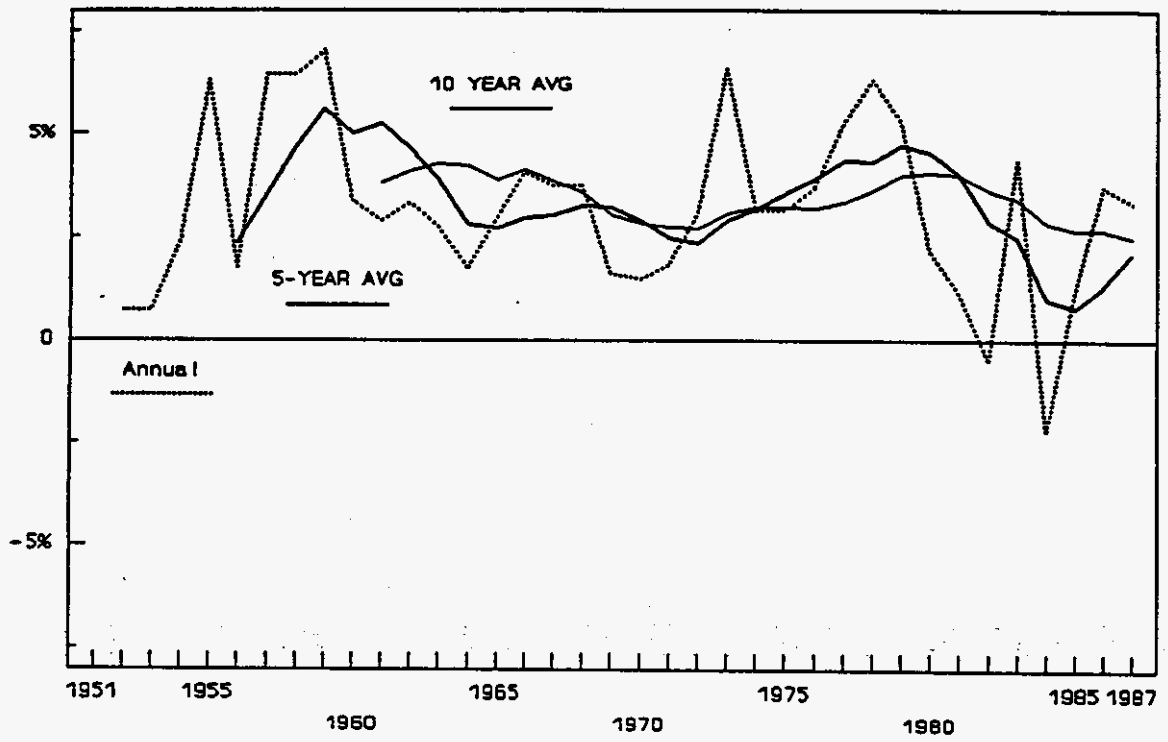


Figure 4
Differences in Annual TFP Growth
Telecommunications - U.S. Private Business

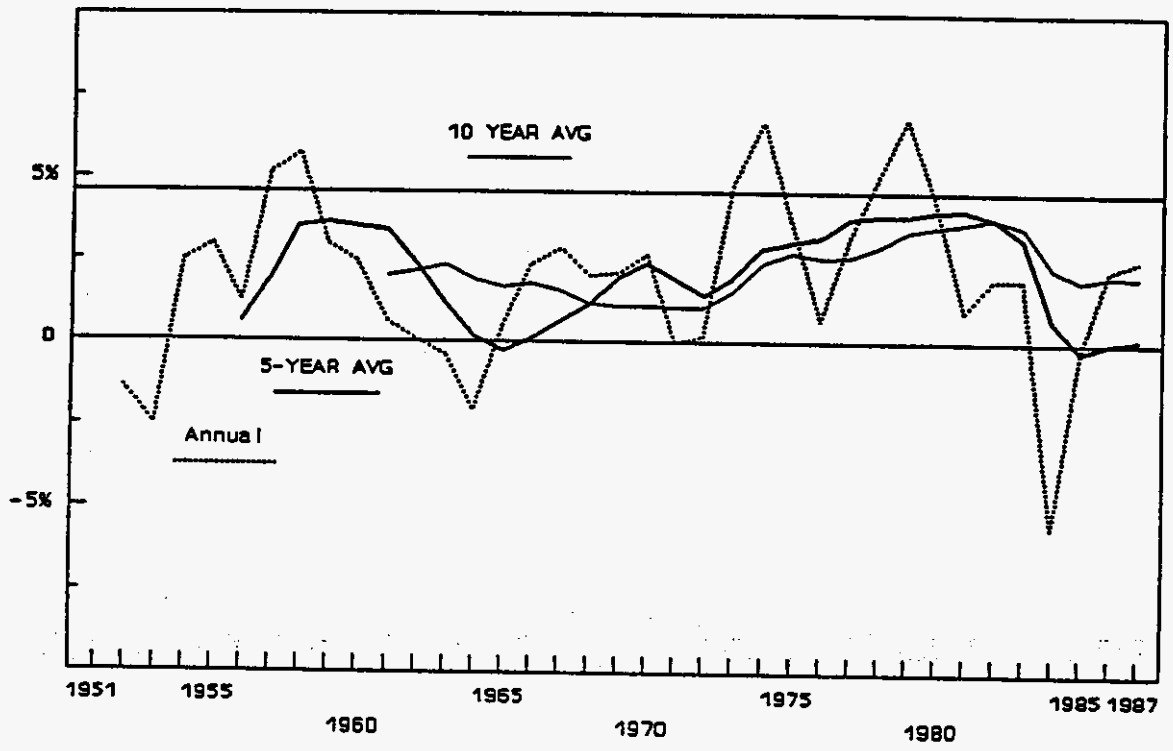
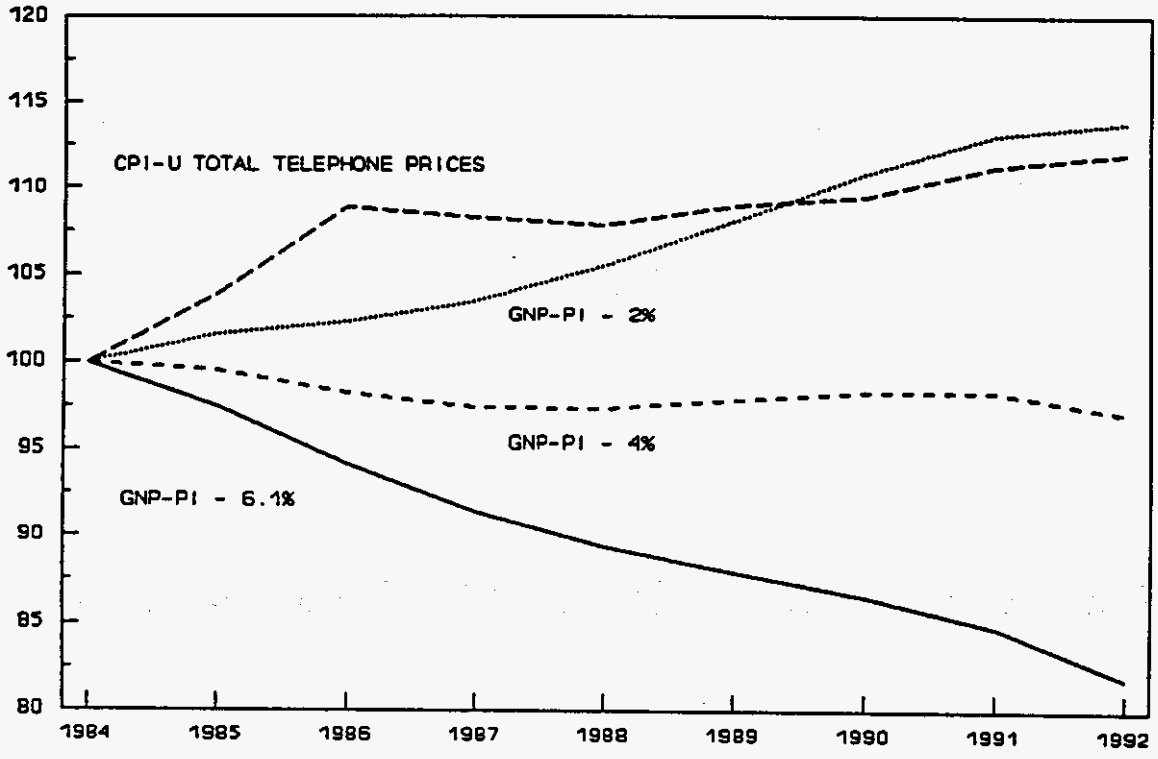


Figure 5
The Historical Productivity Differential
Compared with Proposed Targets



WILLIAM E. TAYLOR

BUSINESS ADDRESS

National Economic Research Associates, Inc.
One Main Street
Cambridge, Massachusetts 02142
(617) 621-2615

Dr. Taylor received a B.A. *magna cum laude* in Economics from Harvard College, an M.A. in Statistics and a Ph.D. in Economics from the University of California at Berkeley. He has taught economics, statistics, and econometrics at Cornell and the Massachusetts Institute of Technology and was a Research Fellow at the Center for Operations Research and Econometrics at the University of Louvain, Belgium.

At NERA, Dr. Taylor has worked primarily in the field of telecommunications economics on problems of state and federal regulatory reform, competition policy, economic issues concerning broadband network architectures, quantitative analyses of state and federal price cap and incentive regulation proposals, and antitrust and contract litigation in telecommunications markets. He has applied the economic theories of price squeezes and cross-subsidization to long distance telephone, Centrex, and public telephone markets. In the area of environmental regulation, Dr. Taylor has worked on statistical issues in the measurement of emissions levels from coal-fired electric power generators and municipal waste-to-energy facilities.

He has published extensively in the areas of telecommunications policy related to access and in theoretical and applied econometrics. His articles have appeared in numerous telecommunications industry publications as well as *Econometrica*, the *International Economic Review*, the *Journal of Econometrics*, *Econometric Reviews*, the *Antitrust Law Journal*, and *The Encyclopedia of Statistical Sciences*. He has served as a referee for these journals (and others) and the National Science Foundation and is currently an Associate Editor of the *Journal of Econometrics*.

EDUCATION

UNIVERSITY OF CALIFORNIA, BERKELEY
Ph.D., Economics, 1974

UNIVERSITY OF CALIFORNIA, BERKELEY
M.A., Statistics, 1970

HARVARD COLLEGE
B.A., Economics, 1968
(Magna Cum Laude)

EMPLOYMENT

NATIONAL ECONOMIC RESEARCH ASSOCIATES, INC. (NERA)

1988- Senior Vice President, Vice President. Dr. Taylor has been responsible for studies concerning the interaction of regulation and competition in various telecommunications markets, including pay telephones, operator services, and large business switched services, the efficiency benefits of state regulatory reforms such as price caps and incentive regulation, the structure of costs and rates in a broadband ISDN network, historical comparisons of rate-of-return and price cap regulation of interstate telephone access charges, carrier access charges and bypass, regulatory and antitrust concerns with intraLATA competition, and contract and antitrust litigation in the paging industry. In the area of environmental regulation, he has studied statistical problems associated with measuring the level and rate of change of emissions.

BELL COMMUNICATIONS RESEARCH, INC. (Bellcore)

1983-1988 Division Manager, Economic Analysis, formerly Central Services Organization, formerly American Telephone and Telegraph Company. While at Bellcore, Dr. Taylor performed theoretical and quantitative research focusing on problems raised by the implementation of access charges. His work included design and implementation of demand response forecasting for interstate access demand, quantification of potential bypass liability, design of optimal nonlinear price schedules for access charges, design and quantification of methods to disaggregate carrier common line charges, and theoretical and quantitative analysis of price cap regulation of access charges.

Journal of Econometrics, North-Holland Publishing Company.

1985- Associate Editor.

BELL TELEPHONE LABORATORIES

1975-1983 Member, Technical Staff, Economics Research Center. Performed basic research on theoretical and applied econometrics, focusing on small sample theory, panel data and simultaneous equations systems.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Fall 1977 Visiting Associate Professor, Department of Economics. Taught graduate courses in econometrics.

CORNELL UNIVERSITY

1972-1975 Assistant Professor, Department of Economics. (On leave 1974-1975.) Taught graduate and undergraduate courses on econometrics, microeconomic theory and principles.

CENTER FOR OPERATIONS RESEARCH AND ECONOMETRICS
Université Catholique de Louvain, Belgium.

1974-1975 Research Associate. Performed post-doctoral research on finite sample econometric theory and on cost function estimation.

BELL TELEPHONE LABORATORIES

1973-1974 Consultant.

TESTIMONIES

Florida Public Service Commission (Docket No. 820537-TP) on behalf of Southern Bell Telephone and Telegraph Company: economic analysis of premium intraLATA access charges. Filed July 22, 1983.

Arkansas Public Service Commission (Docket No. 83-042-U) on behalf of Southwestern Bell Telephone Company: economic analysis of non-traffic sensitive cost recovery proposals. Filed October 7, 1985.

Florida Public Service Commission (Docket No. 820400-TP) on behalf of Southern Bell Telephone and Telegraph Company: economic principles underlying a proposed method for calculating marginal costs for private lines services. Filed June 25, 1986.

Federal Communications Commission (Docket No. 87-313) on behalf of Bell Communications Research, Inc.: empirical analysis of the United States Telephone Association proposal for price cap regulation of interstate access service, entitled "The Impact of Federal Price Cap Regulation on Interstate Toll Customers". Filed March 17, 1988.

Florida Public Service Commission (Docket No. 880069-TL) on behalf of Southern Bell Telephone and Telegraph Company: economic incentives for firms under the proposed Florida Rate Stabilization Plan. Filed June 10, 1988.

California Public Utilities Commission (Case 88-04-029) on behalf of Pacific Bell: commission payment practices, cross-subsidization of pay telephones, and compensation payments to competitive pay telephone suppliers. Filed July 11, 1988.

Federal Communications Commission (Docket No. 87-313) on behalf of Bell Communications Research, Inc.: empirical analysis of the price cap plan proposed in the FCC Further Notice of Proposed Rulemaking, entitled "The Impact of the FCC Proposed Price Cap Plan on Interstate Consumers". Filed August 18, 1988.

Federal Communications Commission (Docket No. 87-313) on behalf of Bell Communications Research, Inc.: Rebuttal analysis of intervenor comments on "The Impact of the FCC Proposed Price Cap Plan on Interstate Consumers". Filed November 18, 1988.

New Hampshire Public Service Commission (Docket 89-010)) on behalf of New England Telephone & Telegraph Company: appropriate level and structure of productivity adjustments in a proposed price regulation plan. Filed March 3, 1989.

Delaware Public Service Commission (Docket No. 86-20, Phase II) on behalf of The Diamond State Telephone Company: appropriate costing and pricing methods for a regulated firm facing competition, in connection with a proposed rate reduction. Filed March 31, 1989. Rebuttal testimony filed November 17, 1989.

Federal Communications Commission (Docket No. 87-313) on behalf of the United States Telephone Association: analysis of an AT&T filing and an empirical analysis of productivity growth under price cap regulation, entitled "Analysis of AT&T's Comparison of Interstate Access Charges Under Incentive Regulation and Rate of Return Regulation." Filed as Reply Comments regarding the FCC's Report and Order and Second Further Notice of Proposed Rulemaking in CC Docket 87-313, August 3, 1989.

New York State Public Service Commission (Case 28961 - Fifth Stage) on behalf of New York Telephone Company: appropriate level and structure of productivity adjustments in a proposed price regulation plan. Filed September 15, 1989.

Georgia Public Service Commission (Docket No. 3882-U) on behalf of Southern Bell Telephone and Telegraph Company: analysis of incentive regulation plans. Filed September 29, 1989.

Public Utility Commission of Texas (Docket No. 8585) on behalf of Southwestern Bell Telephone Company: analysis of Texas intrastate switched access charges and bypass of switched access. Filed December 18, 1989.

Federal Communications Commission (Docket 87-313) on behalf of the United States Telephone Association: analysis of appropriate productivity offsets for local exchange carriers in the FCC price cap plan, entitled "Local Exchange Carrier Productivity Offsets for the FCC Price Cap Plan," May 3, 1990.

Federal Communications Commission (Docket 87-313) on behalf of the United States Telephone Association: analysis of appropriate productivity offsets for local exchange carriers in the FCC price cap plan, entitled "Productivity Offsets for LEC Interstate Access," June 8, 1990.

Federal Communications Commission (Docket 87-313) on behalf of the United States Telephone Association: analysis of appropriate productivity offsets for mid-size telephone companies in the FCC price cap plan, entitled "Interstate Access Productivity Offsets for Mid-Size Telephone Companies," June 8, 1990.

State of Maine Public Utilities Commission (Docket No. 89-397) on behalf of New England Telephone & Telegraph Company: theoretical and historical analysis of incentive regulation in telecommunications, entitled "Incentive Regulation in Telecommunications," filed June 15, 1990.

Illinois Commerce Commission (Docket No. 88-0412) on behalf of Illinois Bell Telephone Company: analysis of pricing issues for public telephone service. Filed August 3, 1990. Rebuttal testimony filed December 9, 1991.

Delaware Public Service Commission (Docket No. 89-24T) on behalf of The Diamond State Telephone Company: rebuttal testimony describing the appropriate costing and pricing methods for the provision of contract Centrex services by a local exchange carrier. Filed August 17, 1990.

Montana Public Service Commission (Docket No. 90.8.46) on behalf of US West Communications: theoretical and historical analysis of incentive regulation plans in telecommunications. Filed October 4, 1990.

Arizona State Air Pollution Control Hearing Board (Docket No. A-90-02) on behalf of Arizona Public Service Company. A statistical study of SO_2 emissions entitled, "Analysis of Cholla Unit 2 SO_2 Compliance Test Data," (October 24, 1990) and an Affidavit (December 7, 1990).

Canadian Radio-Television and Telecommunications Commission (Docket No. 1990-73) on behalf of Bell Canada: "The Effect of Competition on U.S. Telecommunications Performance," (with L.J. Perl). Filed November 30, 1990.

New Jersey Board of Public Utilities (Docket No. TX90050349) on behalf of New Jersey Bell Telephone Company: theoretical and empirical analysis of the Board's intraLATA compensation policy. Filed December 6, 1990.

Federal Communications Commission (Docket 87-313) on behalf of the United States Telephone Association: analysis of total factor productivity calculations, entitled "Productivity Measurements in the Price Cap Docket," December 21, 1990.

Tennessee Public Service Commission (In re: The Promulgation of Agency Statements of General Applicability to Telephone Companies That Prescribe New Policies and Procedures for Their Regulation) on behalf of South Central Bell Telephone Company: theoretical analysis and appraisal of the proposed Tennessee Regulatory Reform Plan. Filed February 20, 1991.

Florida Public Service Commission (Docket No. 900633-TL) on behalf of Southern Bell Telephone and Telegraph Company: alternative measures of cross-subsidization. May 9, 1991.

Federal Communications Commission (Docket 87-313) on behalf of BellSouth Corporation, "The Treatment of New Services under Price Cap Regulation," (with Alfred E. Kahn), June 12, 1991.

Federal Communications Commission (Docket 91-141, In the Matter of Expanded Interconnection with Local Telephone Company Facilities) on behalf of Bell Atlantic, "Effects of Competitive Entry in the U.S. Interstate Toll Markets." August 6, 1991.

California Public Utilities Commission (Phase II of Case 90-07-037) on behalf of Pacific Bell: economic analysis of the effects of FAS 106, (accrual accounting for post-retirement benefits other than pensions) under state price cap regulation, (with Timothy J. Tardiff). Filed August 30, 1991. Supplemental testimony filed January 21, 1992.

Federal Communications Commission (Docket 91-141, In the Matter of Expanded Interconnection with Local Telephone Company Facilities) on behalf of Southwestern Bell, "Economic Effects of the FCC's Tentative Proposal for Interstate Access Transport Services." Filed September 20, 1991.

Rhode Island Public Utilities Commission (Docket No. 1997) on behalf of New England Telephone & Telegraph Company, "Rhode Island Price Regulation Plan," analysis of proposed price regulation plan and evidence of the effects of incentive regulation on prices and infrastructure development. Filed September 30, 1991.

Montana Public Service Commission (Docket No. 90.12.86) on behalf of US West Communications: economic analysis of a proposed incentive regulation plan. Filed November 4, 1991. Additional testimony filed January 15, 1992.

Michigan Circuit Court (Case No. 87-709234-CE and 87-709232-CE) on behalf of Combustion Engineering, Inc., testimony regarding statistical analysis of air pollution data to determine emissions limits for the Detroit municipal waste-to-energy facility, in the lawsuit entitled *Her Majesty the Queen, et al., v. Greater Detroit Resource Recovery Authority, et al.*, February, 1992.

Federal Communications Commission, (Pacific Bell Tariff F.C.C. No. 128, Transmittal No. 1579) on behalf of Pacific Bell, "The Treatment of FAS 106 Accounting Changes Under FCC Price Cap Regulation," (with T.J. Tardiff). Filed April 15, 1992. Reply comments filed July 31, 1992.

New York Public Service Commission (Case No. 28425) on behalf of New York Telephone Company, "Costs and Benefits of IntraLATA Presubscription," (with T.J. Tardiff), filed May 1, 1992.

California Public Utilities Commission, (Docket No. I.87-11-033), on behalf of Pacific Bell, "The New Regulatory Framework 1990-1992: An Economic Review," (with T.J. Tardiff), filed May 1, 1992.

New Hampshire Public Service Commission, (Docket DE 90-002), on behalf of New England Telephone & Telegraph Company: the appropriate relationship between carrier access and toll prices. Filed May 1, 1992. Reply testimony filed July 10, 1992. Rebuttal testimony filed August 21, 1992.

Delaware Public Utilities Commission, (Docket No. 33), on behalf of Diamond State Telephone Company, "Incentive Regulation of Telecommunications Utilities in Delaware," filed June 22, 1992.

Federal Communications Commission, (CC Docket 92-141, In the Matter of 1992 Annual Access Tariff Filings) on behalf of Bell Atlantic, "Effects of Competitive Entry in the U.S. Interstate Toll Markets: An Update," filed July 10, 1992.

Florida Public Service Commission (Docket No. 920385-TL) on behalf of Southern Bell Telephone and Telegraph Company: the economic relationship between depreciation rates, investment, and infrastructure development. September 3, 1992.

Maryland Public Service Commission (Case No. 8462) on behalf of The Chesapeake and Potomac Telephone Company of Maryland: competition and the appropriate regulatory treatment of Yellow Pages, filed October 2, 1992.

Federal Communications Commission (ET Docket 92-100) on behalf of BellSouth Corporation, "Assigning PCS Spectrum: An Economic Analysis of Eligibility Requirements and Licensing Mechanisms," (with Richard Schmalensee), filed November 9, 1992.

PUBLICATIONS

"Smoothness Priors and Stochastic Prior Restrictions in Distributed Lag Estimation," International Economic Review, 15 (1974), pp. 803-804.

"Prior Information on the Coefficients When the Disturbance Covariance Matrix is Unknown," Econometrica, 44 (1976), pp. 725-739.

"Small Sample Properties of a Class of Two Stage Aitken Estimators," Econometrica, 45 (1977), pp. 497-508.

"The Heteroscedastic Linear Model: Exact Finite Sample Results," Econometrica, 46 (1978), pp. 663-676.

"Small Sample Considerations in Estimation from Panel Data," Journal of Econometrics, 13 (1980) pp. 203-223.

"Comparing Specification Tests and Classical Tests," Bell Laboratories Economics Discussion Paper, 1980 (with J.A. Hausman).

"Panel Data and Unobservable Individual Effects," Econometrica, 49 (1981), pp. 1377-1398 (with J.A. Hausman).

"On the Efficiency of the Cochrane-Orcutt Estimator," Journal of Econometrics, 17 (1981), pp. 67-82.

"A Generalized Specification Test," Economics Letters, 8 (1981), pp. 239-245 (with J.A. Hausman).

"Identification in Linear Simultaneous Equations Models with Covariance Restrictions: An Instrumental Variables Interpretation," Econometrica, 51 (1983), pp. 1527-1549 (with J.A. Hausman).

"On the Relevance of Finite Sample Distribution Theory," Econometric Reviews, 2 (1983), pp. 1-84.

"Universal Service and the Access Charge Debate: Comment," in P.C. Mann and H.M. Trebbing (editors) Changing Patterns in Regulation, Markets, and Technology: The Effect on Public Utility Pricing. The Institute of Public Utilities, Michigan State University, 1984.

"Recovery of Local Telephone Plant Costs under the St. Louis Plan," in P.C. Mann and H.M. Trebbing (editors) Impact of Deregulation and Market Forces on Public Utilities. The Institute of Public Utilities, Michigan State University, 1985.

"Access Charges and Bypass: Some Approximate Magnitudes," in W.R. Cooke (editor) Proceedings of the Twelfth Annual Telecommunications Policy Research Conference, 1985.

"Federal and State Issues in Non-Traffic Sensitive Cost Recovery," in Proceedings from the Telecommunications Deregulation Forum, Karl Eller Center, College of Business and Public Administration, University of Arizona, Tucson, Arizona, 1986.

"Panel Data" in N.L. Johnson and S. Kotz (editors), Encyclopedia of Statistical Sciences, John Wiley & Sons, New York, 1986.

"An Analysis of Tapered Access Charges for End Users," in P.C. Mann and H.M. Trebbing (editors) New Regulatory and Management Strategies in a Changing Market Environment. The Institute of Public Utilities, Michigan State University, 1987 (with D.P. Heyman, J.M. Lazorchak, and D.S. Sibley).

"Efficient Estimation and Identification of Simultaneous Equation Models with Covariance Restrictions," Econometrica, 55 (1987), pp. 849-874 (with J.A. Hausman and W.K. Newey).

"Alternative NTS Recovery Mechanisms and Geographic Averaging of Toll Rates," in Proceedings of the Thirteenth Annual Rate Symposium: Pricing Electric, Gas, and Telecommunications Services. The Institute for the Study of Regulation, University of Missouri, Columbia, 1987.

"Price Cap Regulation: Contrasting Approaches Taken at the Federal and State Level," in W. Bolter (editor), Federal/State Price-of-Service Regulation: Why, What and How?, Proceedings of the George Washington University Policy Symposium, December 1987.

"Local Exchange Pricing: Is There Any Hope ?", in J. Alleman (editor), Local Exchange Pricing: The Challenge of the Future, Ballinger Publishing Company, Cambridge, Massachusetts, 1989.

"Generic Costing and Pricing Problems in the New Network: How Should Costs be Defined and Assessed," in P.C. Mann and H.M. Trebbing (editors) New Regulatory Concepts, Issues, and Controversies. The Institute of Public Utilities, Michigan State University, 1989.

"Telephone Penetration and Universal Service in the 1980s," in B. Cole (editor), Divestiture Five Years Later, Columbia University Press, New York, New York, 1989, (with L.J. Perl).

"Regulating Competition for IntraLATA Services," in Telecommunications in a Competitive Environment, Proceedings of the Third Biennial NERA Telecommunications Conference, 1989, pp. 35-50.

"Costing Principles for Competitive Assessment," in Telecommunications Costing in a Dynamic Environment, Bellcore-Bell Canada Conference Proceedings, 1989 (with T.J. Tardiff).

"Optional Tariffs for Access in the FCC's Price Cap Proposal," in M. Einhorn (ed.), Price Caps and Incentive Regulation in the Telecommunications Industry, Kluwer, 1991 (with D.P. Heyman and D.S. Sibley).

"Alternative Measures of Cross-Subsidization," prepared for the Florida Workshop on Appropriate Methodologies for the Detection of Cross--Subsidies, June 8, 1991.

"Predation and Multiproduct Firms: An Economic Appraisal of the Sievers-Albery Results," Antitrust Law Journal, 30 (1992), pp. 785-795.

"Lessons for the Energy Industries from Deregulation in Telecommunications," Proceedings of the 46th Annual Meeting of the Federal Energy Bar Association, May, 1992.

"Efficient Price of Telecommunications Services: The State of the Debate," Review of Industrial Organization, (1992, to appear).

"Status and Results of Regulatory Reform in the U.S. Telecommunications Industry," in C.G. Stalon, Regulatory Responses to Continuously Changing Industry Structures, The Institute of Public Utilities, Michigan State University, 1992.

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PRODUCTIVITY GROWTH IN THE FLORIDA PRICE CAP FORMULA

1. Summary

In Southern Bell's price cap proposal, a productivity target X is established, inflation (GNP-PI) is observed annually, and exogenous cost changes (Z-adjustments) are calculated whenever appropriate so that if Southern Bell meets its productivity objective, the allowed change in Southern Bell's prices will be equal to the change in its costs. If Southern Bell exceeds the target, prices can grow faster than costs (market conditions permitting), and if it fails to reach the target, costs will grow faster than prices. This attachment presents the derivation of the price cap formula proposed by Southern Bell that has this characteristic.

The attachment shows that:

- The price cap formula depends upon an annual measure of inflation, a fixed productivity target, and an appropriate measure of exogenous cost changes.
- The change in GNP-PI is a measure of national inflation or output price growth and embodies the change in national productivity.
- The appropriate productivity target (X) is the Total Factor Productivity (TFP) growth rate for the telecommunications industry relative to U.S. industry as a whole (or relative to the TFP growth already embodied in the GNP-PI).
- In the determination of X, TFP is the only appropriate measure of productivity growth. Partial measures of productivity growth--such as labor productivity--are not correct.
- Exogenous cost changes (Z-factor) are also measured relative to the effect of the exogenous change on U.S. industry as a whole. Exogenous cost changes can be positive or negative.
- Revenue-weighted output growth must be used in calculating the TFP growth differential for the price cap plan.

2. Total Factor Productivity is Required by the Price Cap Formula

The purpose of the annual price cap adjustment is to insure that if the regulated firm meets its productivity growth objective, its adjusted revenues will just track its costs every year, whatever the level of inflation happens to be. In the proposed Florida plan, we fix a productivity target X, annually observe inflation measured by GNP-PI, and calculate exogenous cost changes (Z-adjustments) whenever appropriate so that if the productivity objective is met, the allowed change in the regulated firm's price will be close to its change in costs. Thus, our explanation begins with the total factor productivity (TFP) growth objective for the regulated firm, *dTFP*, which represents the annual year-over-year percentage growth in the regulated firm's TFP. From the productivity growth target and the objective of having revenues track costs, we derive below the annual price cap adjustment formula used in the Florida plan.

For use in the price cap formula, total factor productivity (TFP) is the only appropriate measure of productivity growth. First, use of TFP in setting a productivity target avoids distortions in the incentives of the firm. If, for example, earnings of the regulated firm were tied somehow to attainment of a labor productivity objective, the firm would have the incentive to hire labor until the point at which the average productivity of labor was maximized. This input choice rule is generally inconsistent with the rule followed by profit-seeking firms in unregulated markets: to hire labor until the value of the additional product made possible by the last worker just equals the wage rate. Second, given the structure of the annual price cap adjustment formula, only total factor productivity can be used to set the productivity target.

The annual price cap adjustment formula is designed so that if the firm achieves its productivity target, the allowed growth in its price cap will just equal the realized growth in input prices. Assume the price cap plan begins with appropriate prices so that the value of total inputs (including a normal return on capital) equals the value of total output. We can write this relationship as

$$\sum_{i=1}^{N} p_i Q_i = \sum_{j=1}^{M} w_j R_j \quad ,$$

where the firm has N outputs (Q_i, i=1,...,N) and M inputs (R_j, j=1,...,M) and where p_i and w_j denote output and input prices respectively. We want to calculate a productivity target so that--if the firm meets the productivity target--this relationship holds identically at all points in time.

Differentiating this identity with respect to time yields

$$\sum_{i=1}^{N} \dot{p}_i Q_i + \sum_{i=1}^{N} p_i \dot{Q}_i = \sum_{j=1}^{M} \dot{w}_j R_j + \sum_{j=1}^{M} w_j \dot{R}_j \ ,$$

where a dot indicates a derivative with respect to time. Dividing both sides of the equation by the value of output ($REV = \sum_i p_i Q_i$ or $C = \sum_j w_j R_j$), we obtain

$$\sum \dot{p}_i \left(\frac{Q_i}{REV} \right) + \sum \dot{Q}_i \left(\frac{p_i}{REV} \right) = \sum \dot{w}_j \left(\frac{R_j}{C} \right) + \sum \dot{R}_j \left(\frac{w_j}{C} \right) \ ,$$

where REV and C denote revenue and cost. If rev_i denotes the revenue share of output i and c_j denotes the cost share of input j, then

(1) $$\sum_i rev_i \, dp_i = \sum_j c_j \, dw_j - \left[\sum_i rev_i \, dQ_i - \sum_j c_j \, dR_j \right] \ , \quad \text{where } d = dp_i = \dot{p}_i / p_i \ .$$

The first term in equation (1) is the revenue-weighted average of the rates of growth of output prices, and the second is the cost-weighted average of the rates of growth of input prices. The term in brackets is the difference between weighted averages of the rates of growth of outputs and inputs. It thus is a measure of the change in TFP. Rewriting the equation for clarity, we see that

$$dp = dw - dTFP \ .$$

In words, the theory underlying the proposed Florida plan's annual adjustment formula implies that the rate of growth of a revenue-weighted output price index is equal to the rate of growth of an expenditure-weighted input price index plus the change in total factor productivity, not labor productivity or any other productivity measure. This equation demonstrates that total factor productivity is the appropriate foundation for a productivity target in the price cap plan: if the plan begins with revenues which just match costs--and if the firm attains a productivity goal measured in terms of total factor productivity--then the firm's revenues will continue to match its costs.

3. Derivation of the Price Cap Formula

We showed above that the rate of growth of TFP is equal to the difference between the rates of growth of the firm's input prices and output prices. Applying this rule to Southern Bell firm, we write

$$dp^* = dw - dTFP$$

where dp^* represents the annual percentage change in Southern Bell's output prices, and dw represents the annual percentage change in its input prices. To raise or lower the firm's output price in order to track exogenous changes in cost, we write

(2) $$dp = dw - dTFP + Z^*$$

where dp represents the annual percentage change in Southern Bell's output prices adjusted for exogenous cost changes, and Z^* represents the unit change in costs due to external circumstances.[1] Thus, to keep Southern Bell's revenues equal to its costs despite inflation, the price cap formula should (i) increase the firm's output prices at the same rate as its input prices less the target change in productivity growth, and (ii) directly pass through exogenous cost changes.

Equation (2) looks a great deal like the annual adjustment equation in the proposed Florida price cap plan: the allowed price change for the firm is set at a measure of its input price change less its TFP growth

[1]Note that Z^* can be positive or negative.

adjusted for exogenous cost pass-throughs. If GNP-PI were taken as a measure of the firm's input price growth and X were the firm's TFP growth target, equation (2) would indeed be the same as the proposed Florida price adjustment formula. However there are two errors in this interpretation:

1. The GNP-PI is a measure of national output price growth, not input price growth. So even if the regulated firm is a microcosm of U.S. industry, GNP-PI is not an appropriate measure of its input price growth.[2]

2. X in the price cap plan is a target TFP growth rate for the regulated firm relative to U.S. industry as a whole (or relative to the TFP growth already embodied in the GNP-PI). The change in TFP in equation (2) is the absolute TFP growth for the regulated firm. Again, unless U.S. TFP growth is 0, X is not equal to *dTFP*.

To get from equation (2) to the price adjustment formula, we must compare the productivity growth of the regulated firm or industry with the productivity growth of the U.S. economy. The reason for this comparison is that it is difficult to measure input price growth objectively. In particular, no competent party outside of the industry, such as the Bureau of Labor Statistics or the American Productivity Center, maintains an index of telecommunications input prices. However, by comparing productivity growth of the firm or industry with that of the U.S. economy, the difficult measurement of input price growth can be avoided.

For the U.S. economy as a whole, the relationship among input prices, output prices, productivity, and exogenous cost changes can be derived in the same manner as it was derived in equation (2) above:

(3) $$dp^N = dw^N - dTFP^N + Z^{*N}$$

where dp^N is the annual percentage change in a national index of output prices; dw^N is the annual percentage change in a national index of input prices; $dTFP^N$ is the annual change in the economy-wide total factor productivity, and Z^{*N} represents the change in national output prices caused by the exogenous factors included in equation (2). If we subtract equation (3) from equation (2), we see that

[2]Recall that input price growth differs from output price growth by the growth in TFP. Only if $DTFP^N$ were 0 could GNP-PI be a good measure of national input price growth.

$$dp - dp^N = [dw - dw^N] - [dTFP - dTFP^N] + [Z^* - Z^{*N}] \ ,$$

or

(4) $$dp = dp^N - [\ dTFP - dTFP^N + dw^N - dw\ ] + [\ Z^* - Z^{*N}\ ] \ .$$

Equation (4) is the theoretical equivalent of the price adjustment formula. The allowed price change for the regulated firm for a particular year is given by:

1. the rate of inflation of national output prices dp^N, (GNP-PI),
2. less a fixed productivity offset, X, which represents a target productivity growth differential between the regulated firm or industry and the U.S. economy,[3]
3. plus unit exogenous cost changes, written as the difference in the unit costs of the exogenous change between the regulated firm and the U.S. economy.

Simple algebra translates equation (4) into the formula that appears in the price cap plan.

$$P_t = P_{t-1} \times [\ 1 + GNP\text{-}PI - X \ \pm Z\ ]$$

where P_t represents an index of the regulated firm's output prices in year t using base period weights.

In words, the change in the regulated firm's output price that will just track the change in its costs, whatever the level of inflation, is equal to (i) the change in a national index of output prices, less (ii) the difference between the change in total factor productivity for the telecommunications firm and for the nation as a whole,[4] plus (iii) the difference between the effect of exogenous changes on the costs of the telephone firm and on the costs of the nation as a whole. This equation is the foundation of the price adjustment formula in the proposed price cap plan. In this plan, GNP-PI and Z are measured annually, but X is fixed as the target

[3]This differential is equal to the difference between the firm and U.S. TFP growth rates only if the rates of input price growth are the same for the firm and the nation: i.e., if $dw = dw^N$. Evidence supporting this assumption was presented by Dr. Laurits Christensen in Appendix F of AT&T's Comments in response to the FCC's Notice of Proposed Rulemaking in CC Docket 87-313, filed October 19, 1987. According to Dr. Christensen's calculations, input cost inflation for the Bell System and for the total U.S. private domestic economy averaged 4.5% and 4.6% respectively for the years 1948 through 1979.

[4]Adjusted for possible differences between input price growth rates for the firm and the nation.

amount by which the firm's TFP growth should exceed U.S. TFP growth. If the firm exceeds its productivity target, revenue growth will exceed cost growth and the firm will make higher profits. If the firm falls short of its productivity target, revenue growth will fall short of cost growth and profits will fall.

4. A Revenue-weighted Output Index is Required by the Price Cap Formula

One purpose of productivity measurement is to calculate the rate of technical change in an industry, where technical change is defined as an outward shift in the industry production function or a downward shift in the industry cost function. Under various assumptions about firm behavior, a measure of technical change can be calculated, and that measure is quite similar to our measure of TFP growth. The conventional measure of TFP growth (as derived above) uses revenue shares as weights in the index of output growth. The proportionate shift in the production or cost function can also be written as the difference between the growth in aggregate output and aggregate input, but the output quantity index implied by the theory uses cost elasticities as weights.[5] Hence our measure of TFP can be used as a measure of technical change only under certain conditions which are unlikely to hold in the telecommunications industry, namely constant returns to scale and marginal cost pricing of services.

This fact, however, does not in any way invalidate our measure of TFP growth for use in the price cap annual adjustment formula. The purpose of the price cap adjustment is to keep the growth of output prices equal to the growth of input prices when a productivity target is attained. Equation (1) describes the relationship between a revenue-weighted output price index, an expenditure-weighted input price index, and a particular measure of TFP growth that uses a revenue-weighted output quantity index. For our purpose, the TFP measure based on revenue-weighted output growth is the only correct measure of TFP growth. Thus since the price cap index is based on revenue weights, it would be incorrect to use a measure of TFP growth based on a cost-elasticity-weighted output quantity index.

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[5]See, for example, M. Denny, M. Fuss, and L. Waverman, "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries, with an Application to Canadian Telecommunications," in T. Cowing and R. Stevenson, Productivity Measurement in Regulated Industries, New York: Academic Press, 1981, p. 197, equation (32e).

Different measures of TFP growth are appropriate for different purposes. To set a productivity target so that a revenue-weighted average of output prices will grow at the same rate as an expenditure-weighted average of input prices when the target is met requires that our measure of TFP growth (in which the output quantity index uses revenue weights) be used in setting the target.

This point is of more than academic interest because rate changes due to competition will make any historical productivity target more difficult to achieve. When the quantity index of output in a TFP calculation uses revenue weights, changes in prices will affect measured growth in TFP. In particular, suppose significant rate rebalancing is undertaken. Currently, the growth rate of toll output is high relative to the growth rate of local exchange service, and the contribution (price less incremental cost) from toll is high relative to that from local exchange service. If toll prices are reduced and local prices are increased, there will be two effects. First, in the short run, (before customers respond to the new price structure), the revenue share of toll will fall which will cause the measured rate of growth of total output to fall. The revenue share of the rapidly growing toll service will fall, and the revenue share of the slow-growing local service will rise.

Second, in the longer run, (after demand stimulation has occurred), we would expect some of this reduction in output growth rates to disappear because of the larger price elasticity of demand for toll than for local service. Toll demand will increase (because of stimulation from its price reduction) by a higher percentage than local demand will decrease (because of repression from its price increase), offsetting to some extent, the reduction in aggregate output due to the shift in revenue weights. The net effect of lowering toll prices and raising local prices will be to reduce TFP growth as it is measured in the price cap formula.[6] All else equal, it will be more difficult to meet a given productivity target in the future--under rebalanced rates--than it was when the productivity target was set, because faster-growing toll services will contribute less to aggregate output.

[6]This is not a reason to avoid rate rebalancing, which by itself would lead to large gains in economic efficiency. Rate rebalancing alters the weights with which growth rates of outputs of different services are averaged, and only through those changes in weights--in the long run--does rate rebalancing affect TFP growth.

HISTORICAL PRODUCTIVITY GROWTH

IN THE U.S. TELECOMMUNICATIONS INDUSTRY

1. Summary

The productivity target X in the proposed price cap formula represents the difference between the total factor productivity (TFP) growth of the telecommunications industry or firm and U.S. industry as a whole. To set a reasonable productivity target for Southern Bell, we should know what the historical long run TFP growth rates have been in the telecommunications industry and in U.S. industry as a whole. Attachment 3 shows that the long run differential between telecommunications productivity growth and U.S. TFP growth is about 2 percentage points per year.

- Several independent direct measures of long run TFP growth show that U.S. productivity growth varies between about 0 and 3 percent per year.
- Several independent direct estimates of the long run TFP growth of the telecommunications industry show TFP growth rates between about 2 and 6 percent.
- Direct measures of the TFP differential thus support a long run productivity differential between the telecommunications industry and the U.S. economy of about 2 percent per year.
- Indirect measures of the TFP differential--based on the difference between the rate of change of telecommunications prices and U.S. output prices--also show that the long run productivity differential is about 2 percent.
- Finally, a 2 percent productivity differential for the telecommunications industry is consistent with the findings of the FCC in implementing its price cap plan and represents an ambitious target for the intrastate services of Southern Bell in Florida. Hence, Southern Bell's proposed productivity target of 4 percent will pass through significantly greater benefits from productivity gains in the form of lower prices to consumers than the industry has been able to do in the past.

2. TFP Growth for U.S. Industry as a Whole

There are several independent estimates of the historical rate of productivity change for U.S. industry. Such TFP studies are routinely performed by government agencies (the Bureau of Labor Statistics), academic economists, independent research organizations (the American Productivity and Quality Center), and--before divestiture--AT&T. Long run productivity change for the telecommunications industry and for the U.S. as a whole has varied slowly over time, so that an accurate estimate of the average difference between productivity for the industry and for the economy can be obtained from historical data. As shown in Figure 1, a ten year moving average of annual productivity change for U.S. industry as measured by (i) the Bureau of Labor Statistics (BLS) and (ii) the American Productivity and Quality Center (formerly the American Productivity Center, abbreviated APC) and L.R. Christensen (of the University of Wisconsin, abbreviated LRC) generally varies between 0 percent and 3 percent. For the entire period that the index is available, (1948-1987), annual productivity growth averaged 1.41 percent (as measured by the BLS), 1.71 percent (as measured by the APC), and 1.24 percent (as measured by LRC). The most recent 10 year average productivity growths in 1987 were 0.42, 0.66, and 0.47 percent as measured respectively by the BLS , the APC, and LRC.

3. TFP Growth for the Telecommunications Industry

Several studies show that the long run average productivity change for the telecommunications industry has varied slowly over time but at a higher rate--generally between 2 percent and 6 percent per year.[1] Figure 2 shows ten year average productivity changes for various definitions of the communications industry: (i) APC, as calculated for the communications industry, (ii) AT&T and L.R. Christensen (abbreviated LRC(1)) for the Bell System, and (iii) Christensen (LRC(2)) and R.W. Crandall of the Brookings Institution (RWC) for the U.S. telecommunications industry. The APC study includes broadcasting which is not included in the LRC(2) and RWC studies. For the periods that the indices are available, annual productivity growth averaged between 3.97 and 3.17 percent. The most recent 10 year average productivity growths ranged from 3.91 to 2.34 percent as measured by

[1]This does not mean that a reasonable productivity target for a price cap plan is between 2 and 6 percent. We must subtract the growth of U.S. TFP from the telecommunications industry TFP to obtain the historical productivity target.

RWC and the APC as of 1987. These TFP calculations along with those for aggregate U.S. industry are presented in Table 1.

4. The Historical Productivity Differential

For the studies outlined above, the estimated telephone productivity differentials are shown in Figure 3, using 10 year averages for each of the estimates of the productivity differential. The APC and LRC(2) estimates represent the difference between APC and LRC(2) estimates of TFP growth rates for both the communications industry and the total U.S. industry. LRC(1), AT&T, and RWC use the BLS estimate of national TFP growth. Figure 3 shows that in recent years, despite fluctuations in the annual rates of productivity growth for the U.S. and the telecommunications industry, the productivity differential has generally remained between 0 and 4 percent. Measures of the differential at the most recent possible date are presented in Table 2, based on productivity growth over the entire period and a ten year average at the end of the period. AT&T and Dr. Christensen both present average differentials (between the Bell System TFP and unpublished studies of the U.S. as a whole) for the 1948-1979 period, and these are noted in Table 2.

Two additional TFP studies corroborate the productivity differential estimates in Figure 3. A 1981 study by M.I. Nadiri and M.A. Schankerman (of New York University and the National Bureau of Economic Research) calculates an average rate of growth of TFP for the Bell System of 4.09 percent from 1947 to 1976 which yields a differential of 2.01 percent. For this particular period, the APC, AT&T, and LRC(1) differentials averaged 2.56 percent, 1.02 percent, and 1.03 percent respectively. A 1988 study by D.W. Jorgenson (summarizing results from a book by Jorgenson, F.M. Gollup, and B.M. Fraumeni) estimates an annual rate of growth of TFP for communications (less broadcasting) of 2.90 percent between 1948 and 1979. A comparable estimate by Jorgenson et. al. of the change in U.S. TFP over the period is 0.81 percent, so that the estimated differential is 2.09 percent.

To interpret the different studies, recall that the APC compares U.S. industry with the communications industry (including broadcasting and miscellaneous communications), AT&T and LRC(1) refer to the Bell System, and LRC(2) and RWC apply to the telecommunications industry.

5. Indirect Measures of the Productivity Differential

A second method of calculating the differential total factor productivity for an industry is based on the rate of change of output prices relative to input prices for a particular industry and for the U.S. economy as a whole. The economic theory of duality implies that the difference in TFP growth between the telecommunications industry and the nation as a whole can be calculated from the difference in their output price growth rates, adjusted for exogenous cost change differences.

Table 3 presents various estimates of the telecommunications productivity differential, using the consumer price index (CPI-U) and the GNP price deflator (GNP-PI) as measures of the change in national output prices and the CPI total telephone price index (CPI-T) as a measure of the change in telecommunications output prices. The differential based on GNP-PI as the index of output prices is significantly lower than that based on the CPI-U, at least for recent periods. Although there is some variation in all estimates over different time periods, the data are consistent with an average differential of 2 percent. Of particular interest are the long-run estimates of the productivity differential by Spavins and Lande which show a differential of 1.7 percent since 1929.

Figure 4 shows two calculations of the long run productivity differential based on the differences (i) between the GNP-PI deflator and the CPI total telephone price index and (ii) between the CPI-U price index for all commodities and the CPI total telephone price index. Except for the period just prior to divestiture, these measures of the relative productivity growth of the telecommunications industry remain between 1 percent and 3 percent. Note that the productivity differential as measured by the more appropriate GNP-PI comparison is consistently lower than that using the CPI, and that since divestiture, the ten year average has been falling and is less than 2 percent.

An alternative interpretation of these results is that--irrespective of productivity growth--the difference between inflation and a price index of total telephone service measures the real rate of price changes that customers have experienced over the period. Thus averaged over the past ten years, U.S. telephone customers have encountered a rate of real price decrease of approximately 2 percent per year.

6. Comparison with the FCC Productivity Target

Our historical TFP differential is consistent with the productivity target used by the FCC in its price cap plan for local exchange carrier interstate services. The FCC has implemented a productivity offset of 3 percent in its price regulation plan for AT&T and 3.3 percent for its price regulation plan for the interstate access services of the LECs. (A LEC may select a productivity offset of 4.3 percent in exchange for a more favorable sharing proportion for earnings above 12.25 percent.) The FCC's adoption of 3 percent as a productivity offset for AT&T derives primarily from their analysis of AT&T's post-divestiture output prices (Further Notice of Proposed Rulemaking, CC Docket 87-313, released May 23, 1988, Appendix C), in which AT&T's MTS prices were shown to have grown approximately 2.48 percent more slowly than the GNP-PI over the post-divestiture period. An explicit "consumer productivity dividend" of 0.5 percent was added to the historical AT&T productivity differential to insure that ratepayers benefitted from the regulatory change.

The productivity offset of 3.3 percent for LECs in the price cap plan reflects several factors which do not apply to intrastate service. First, interstate demand is almost entirely driven by toll traffic and growth in interstate toll traffic, stimulated by lower toll rates, is significantly greater than the growth of intrastate toll or local service. Second, the 3.3 percent offset is specific to the LEC price cap plan, and its value is very sensitive to details such as the treatment of common line demand in the price cap formula. Finally, Appendix D to the Second Report and Order in CC Docket 87-313 showed that a long run productivity differential for the total industry of 1.7 to 2.0 percent would imply an interstate productivity differential of 2.1 to 2.6 percent and an associated intrastate productivity differential of 1.57 to 1.81 percent: T.C. Spavins, "The Long Term View of the Appropriate Productivity Factor for Interstate Exchange Access," pp. 9-10.

7. Conclusions

Based on historical comparisons of TFP growth between the telecommunications industry and the U.S. as a whole, the productivity differential for a price cap formula has averaged about 2 percent. That is, if telephone industry prices had grown at approximately 2 percentage points more slowly than the overall rate of inflation, then telephone prices would have been growing at about the same rate as telephone costs.

TABLES

Table 1
Total Factor Productivity Growth

	PERIOD GROWTH RATE	TEN YEAR AVERAGE (END OF PERIOD)
US INDUSTRY		
BLS: 1948-1987	1.41%	0.42%
APC: 1948-1987	1.71%	0.66%
LRC(2): 1952-1987	1.24%	0.47%
COMMUNICATIONS INDUSTRY		
APC: 1948-1987	3.97%	2.34%
AT&T: 1947-79	3.21%	3.40%
LRC(1): 1947-1979	3.22%	3.41%
LRC(2): 1951-1987	3.17%	2.44%
RWC: 1960-1987	3.37%	3.91%

(1) BLS: Bureau of Labor Statistics, Multiproduct TFP Growth, U.S. Private Business.

(2) APC: American Productivity Center, Multiproduct TFP Growth, U.S. Private Business, Communications Industry.

(3) LRC(1): L.R. Christensen, Testimony filed in United States v. AT&T, Civ. Action No. 74-1698 (D.D.C. filed November 20, 1974).

(4) AT&T: Bell System Productivity Study: 1947-1979, September, 1980.

(5) LRC(2): L.R. Christensen, "Total Productivity Growth in the U.S. Telecommunications Industry and the U.S. Economy: 1951-1987," filed in North Dakota Public Service Commission Case No. PU-2320-90-149, October 1, 1990.

(6) RWC: R.W. Crandall and J. Galst, "Productivity Growth in the U.S. Telecommunications Sector: The Impact of the AT&T Divestiture," The Brookings Institution, July, 1990.

Table 2
TFP Differential
U.S. Industry and Telecommunications

	Growth Rate Differential	End of Period 10 Year Average
1947-76: Nadiri-Schankerman	2.01%	
1948-79: D. Jorgenson	2.09%	
1948-79: L.R. Christensen	2.10%	
1948-79: AT&T	2.00%	
1949-87: APC	2.27%	1.54%
1949-79: LRC(1)	1.57%	2.96%
1949-79: AT&T	1.65%	2.93%
1952-87: LRC(2)	1.95%	2.12%
1961-87: RWC	2.29%	3.28%

(1) M.I. Nadiri and M. Schankerman, "The Structure of Production, Technological Change, and the Rate of Growth of Total Factor Productivity in the U.S. Bell System," in Productivity Measurement in Regulated Industries, (T. Cowing and R. Stevenson, eds.), New York: Academic Press, 1981.

(2) D.W. Jorgenson, "Productivity and Postwar U.S. Economic Growth," The Journal of Economic Perspectives, Fall, 1988, citing D.W. Jorgenson, F.M. Gollup, and B.M. Fraumeni, Productivity and U.S. Economic Growth, Cambridge: Harvard University Press, 1987.

(3) L.R. Christensen: Testimony filed in United States v. AT&T, Civ. Action No. 74-1698 (D.D.C. filed November 20, 1974) comparing unpublished estimates of national TFP growth with cited Bell System productivity growth estimates.

(4) AT&T: Bell System Productivity Study: 1947-1979, September, 1980. comparing unpublished estimates of national TFP growth with cited Bell System productivity growth estimates.

Table 3
Productivity Differentials
Based on Output Price Changes

CPI-U - CPI-TELEPHONE	AVERAGE ANNUAL GROWTH
(1): 1935-1985	1.95%
(1): 1975-1985	2.64%
(2): 1937-1987	1.80%
(2): 1977-1987	2.02%
(3): 1959-1991	2.62%
(4): 1929-89	1.70%
(4): 1946-89	2.00%
GNP-PI - CPI-TELEPHONE	
(5): 1959-1991	1.87%
(6): 1977-1987	1.20%

(1) J.L. Lande and P.L. Wynns, "Primer and Sourcebook on Telephone Price Indexes and Rate Levels," Industry Analysis Division, Common Carrier Bureau, Federal Communications Commission, April, 1987.

(2) "Trends in Telephone Service," Industry Analysis Division, Common Carrier Bureau, Federal Communications Commission, August 1, 1988.

(3) Calculated using exponential growth between average year values. Period is maximum availability for GNP-PI data below.

(4) FCC, Supplemental Notice of Proposed Rulemaking, CC Docket 87-313, March 12, 1990, Appendix D: T. Spavins and J. Lande, "Total Telephone Productivity in the Pre and Post-Divestiture Periods."

(5) Calculated. Period is maximum data availability.

(6) Calculated. Compare with CPI-U number above.

FIGURES

Figure 1
U.S. Total Factor Productivity Growth
10 Year Moving Average

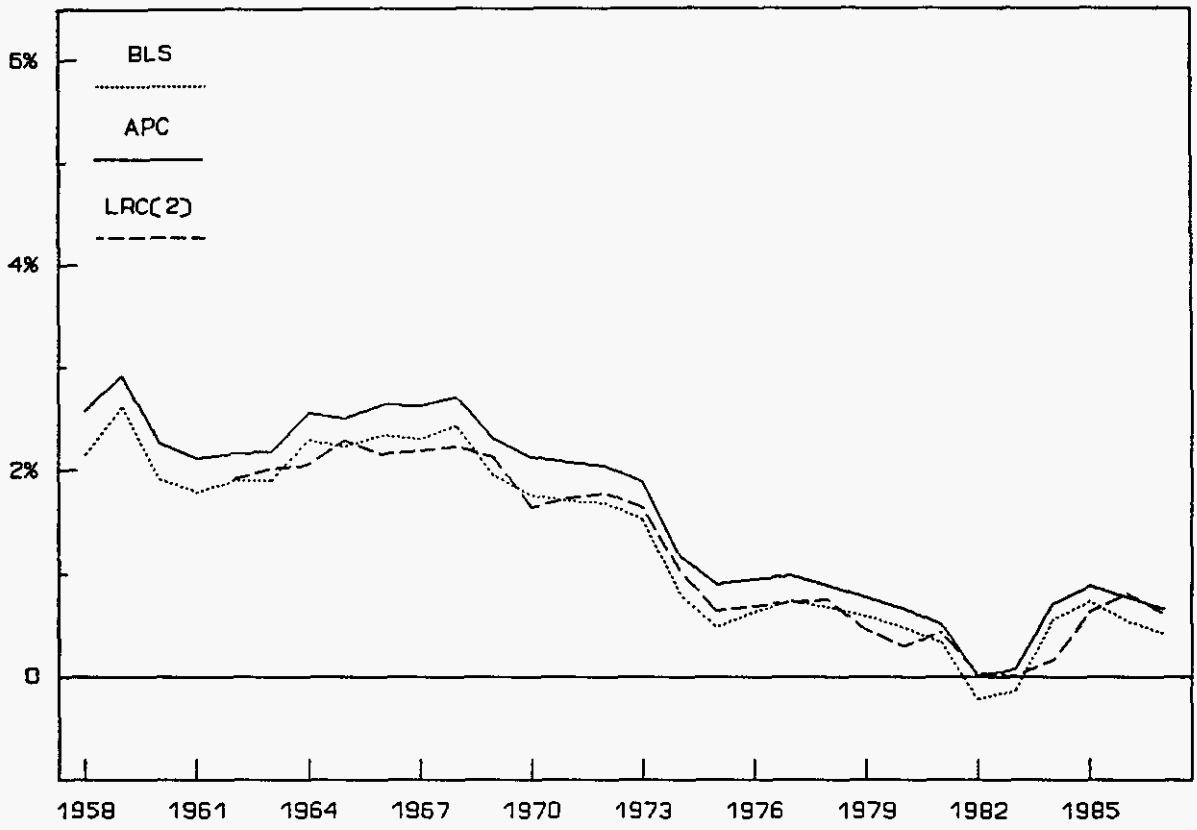


Figure 2
Telecommunications TFP Growth
10 Year Moving Average

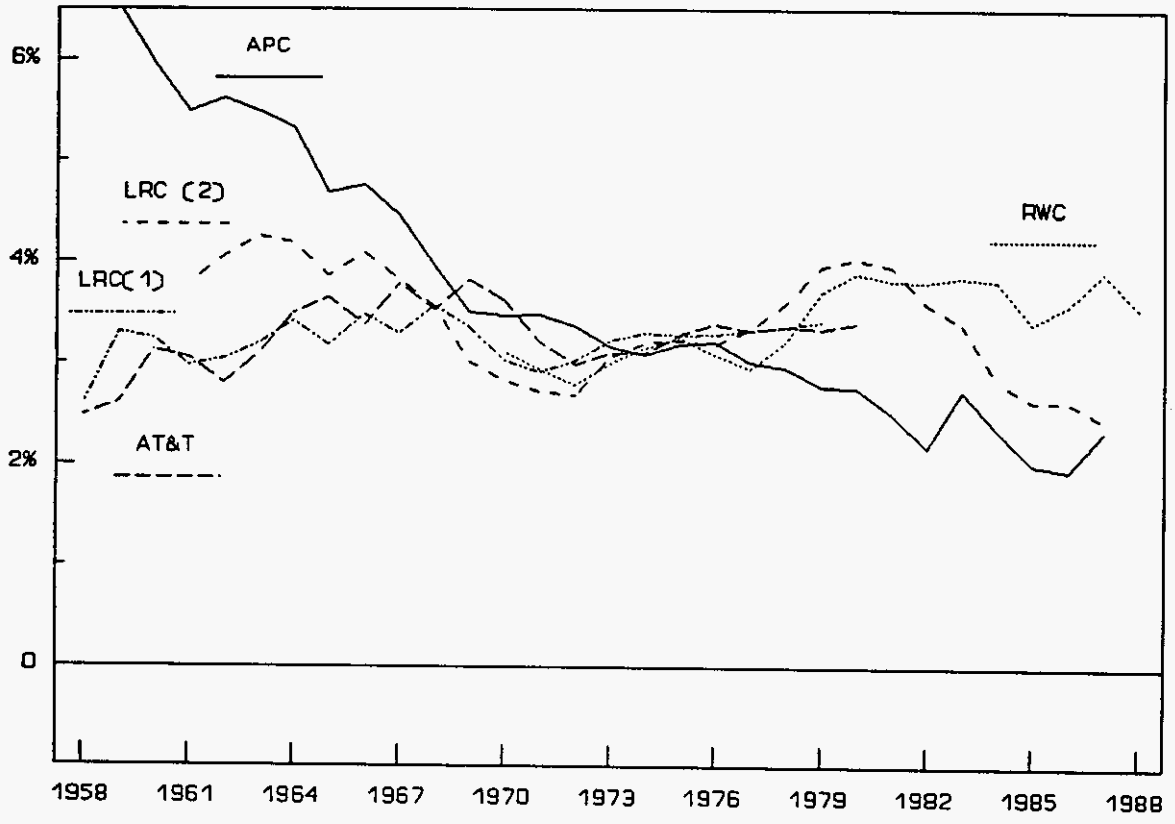


Figure 3
Annual TFP Growth Differential
Telecommunications - Total U.S. Industry
10 Year Moving Averages

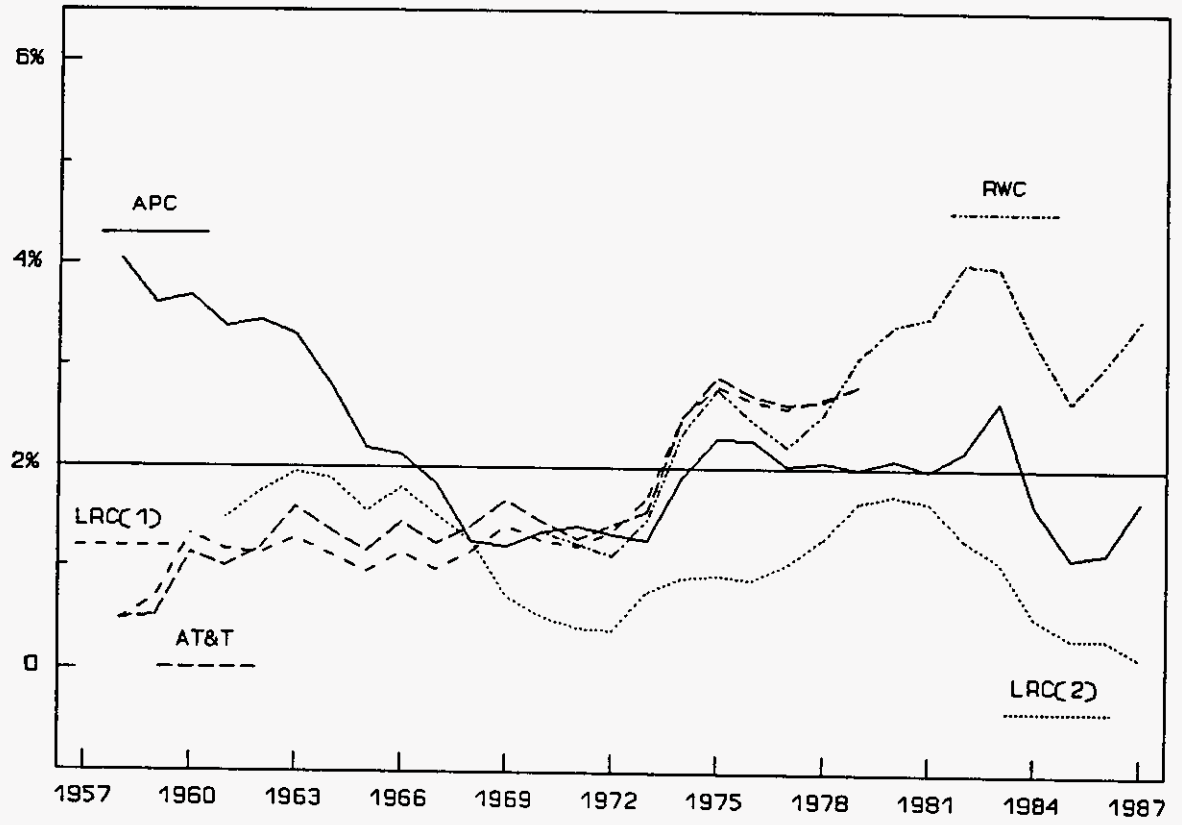
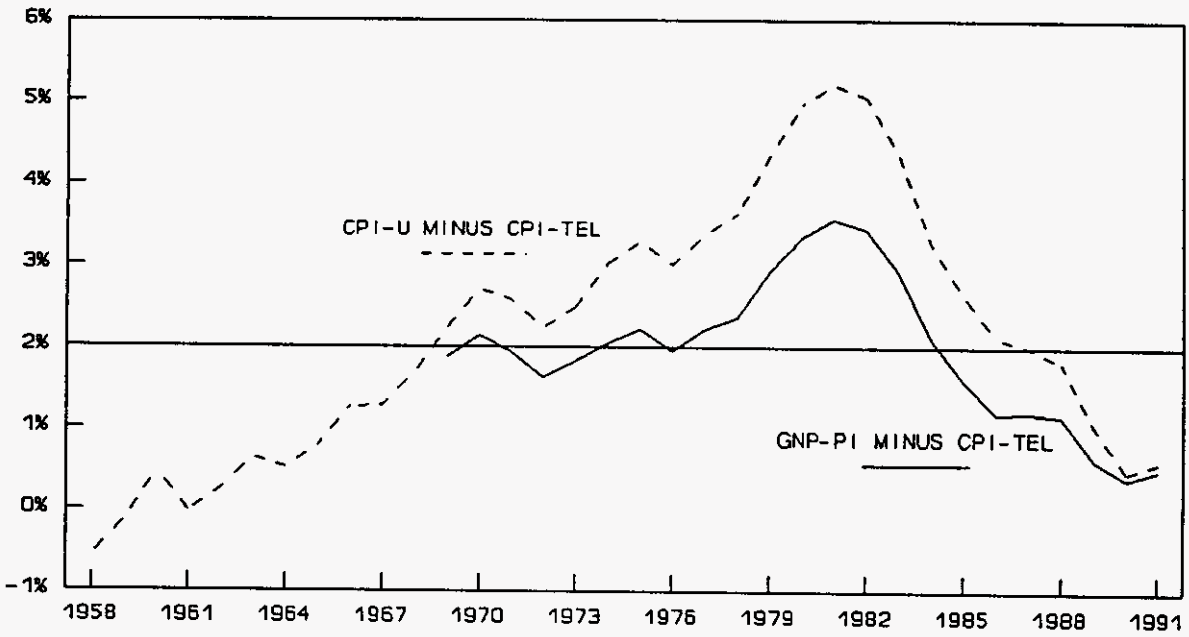


Figure 4
Annual TFP Growth Differential
10 Year Moving Average
Indirect Method



INCENTIVE REGULATION AND THE DIFFUSION OF NEW TECHNOLOGY IN TELECOMMUNICATIONS[1]

I. Summary

Proponents of regulatory reform in telecommunications argue that incentive regulation increases incentives to innovate and accelerates the diffusion of new technology in the network, compared with ordinary rate of return regulation. Attachment 4 compares the implementation of state incentive regulation plans and the rate of diffusion of new technology--over time and across states--and shows that adoption of incentive regulation accelerates the spread of digital switching and optical fiber transmission by about one year and the spread of ISDN and SS7 by about six months, relative to their implementation under rate of return regulation.

II. Introduction

Telephone companies, as well as other public utilities, have been regulated at the state and federal level by various forms of rate of return (RoR) regulation since early in this century. During that period and particularly in the last decade, the industry has undergone radical changes in technology and market structure. Partly in response to those changes, the method of regulating the industry has come under scrutiny, and alternatives to RoR regulation for telephone companies are currently in place or in progress in Britain, in the interstate jurisdiction in the United States, and in approximately 35 states.

At the same time, and partly for the same reasons, concern has arisen regarding the condition of the telecommunications infrastructure in the United States. As thoroughly documented

[1]For more details see William E. Taylor, Charles J. Zarkadas, and J. Douglas Zona, "Incentive Regulation and the Diffusion of New Technology in Telecommunications", a paper presented at the International Telecommunications Society, Ninth International Conference, June 1992.

elsewhere,[2] the technological advantage historically enjoyed by the U.S. telecommunications industry over that of neighbors and trading partners has eroded rapidly since divestiture. The natural question to ask is whether the unique U.S. system of ownership and regulation of the telecommunications network provides adequate incentives for research and development, investment, and diffusion of technical change. Proponents of regulatory reform in telecommunications argue that traditional rate of return regulation reduces the incentive to innovate and retards the diffusion of new technology in the network, compared with various forms of incentive regulation.

In this Attachment, we examine the determinants of the rate of diffusion of new technology in various industries and identify mechanisms by which price and entry regulation influence the rate of adoption and implementation of new technology. Using industry-wide data for the local exchange carriers, we track the implementation of new switching technologies (stored program control and digital), network technologies (equal access, CCSS7, and ISDN) and new transmission technologies (optical fiber) from 1980 through 1994. We specify a pooled time-series cross-section model of the relationship between the adoption and implementation of these technological advances among local operating telephone companies and changes in the form of regulation in the federal jurisdiction and in the states in which they operate. Our results indicate that adoption of incentive regulation plans is strongly associated with more rapid modernization for switching and transmission facilities and somewhat less strongly--though positively--associated with the diffusion of ISDN and SS7 service platforms.

III. Incentive Regulation in the U.S.

A variety of different modifications to RoR regulation have been proposed in the past few years in order to overcome some of the problems discussed above. In general, one can identify a trend towards less frequent regulation (moratoriums, sharing plans, and earning flexibility) and more

[2]See the extensive record in the National Telecommunications and Information Administration's Inquiry on Telecommunications Infrastructure, April, 1990.

flexible regulation (service-specific deregulation, price banding). The implicit and occasionally explicit direction of this trend is towards eventual deregulation of the LEC or the service. Where improved regulation rather than deregulation appears to be the goal, price regulation and social contracts are prevalent.

We identified five types of incentive regulation plans above and assigned many complex state plans to one of these five categories. That assignment does not do justice to the variety of combinations of these five types which appear in the intrastate jurisdiction. Frequently, services deemed to be competitive are deregulated or subjected to reduced regulation, while some other form of incentive regulation is applied to the less competitive services. Similarly, earnings sharing or earnings flexibility appear to be attractive components of other incentive regulation plans, since they reduce the risk to both ratepayers and shareholders from an error in setting some parameter of the plan. While our assignment of plans to the different categories of incentive regulation may be somewhat subjective, we can certainly determine objectively whether or not a state has adopted some form of incentive regulation plan on a certain date.

IV. Results

We can estimate the effect of incentive regulation on the introduction and diffusion of new technology into the telecommunications network by comparing current and planned levels of modernization for local telephone companies with the history of the regulatory system which they face. In general, controlling for effects other than regulatory change which affect the level of modernization selected by a firm, we want to know if firms in states which have adopted various forms of incentive regulation choose (and implement) higher levels of modernization.

Obviously, modernization is only part of the story. Modernization of the network infrastructure is only valuable to the extent that it contributes to cost reduction or demand expansion through new service introductions. An exhaustive study of the benefits of incentive regulation would thus examine total factor productivity growth rather than modernization. Nonetheless, we address the

more narrow question--will incentive regulation encourage infrastructure modernization?--because that argument is used so frequently to advocate adoption of incentive regulation plans.

A. A Model

The economic function we wish to explain is the rate of diffusion of new technology in different parts of the telephone network. A framework for this decision is the assumption that the firm minimizes the cost of producing its observed level of output given:

- its technology, as described by a neoclassical cost or production function,
- the prices it faces for factors of production (say capital, labor, and raw materials), and
- environmental variables, such as regulation, which potentially shift the firm's cost function.

If the cost function is well-behaved, its parameters can be estimated from the system of factor demand equations obtained by differentiating the cost function with respect to input prices. The resulting equations express the demand for factors of production (including loops, switches, and interoffice trunks) as a function of outputs, input prices, and environmental variables from the cost function. Infrastructure modernization is thus represented by the fraction of equipment of various types embodying new technology.

Rather than working directly with the fraction of equipment which embodies new technology, we work with a monotonic transformation of that fraction:

$$y_{i,t} = \ln \frac{P_{i,t}}{1 - P_{i,t}} \quad or \quad P_{i,t} = \frac{1}{1 + \exp(-y_{i,t})}$$

where $P_{i,t}$ is the fraction of equipment incorporating new technology for company i in period t, and $y_{i,t}$ is our index of technology for firm i in period t. The rate of deployment of new technology, and therefore, the level of the index in any given year for a particular company depends on the relative prices of new and old technology, the relative effects of growth in output and the relative effects of

environmental variables. The effects of capital prices are assumed to be common across companies in a given year but varying over time. We specify the relationship between the index and the type of regulation as

$$y_{i,t} = \alpha_t + \gamma_i + \sum_{k=1}^{N} \beta_k \, REG^k_{i,t} + \epsilon_{i,t}, \qquad (1)$$

where i indexes firms, t indexes time, $REG^k_{i,t}$ indicates the length of time that incentive regulation of type k for firm i has been in place at time t, and $y_{i,t}$ represents the index of deployment of a new technology.[3] The statistical disturbance $\epsilon_{i,t}$ is assumed to be independent and identically distributed across firms and over time. The α_t represent time-specific effects that absorb the effect of any unmeasured effects that are constant across firms at any point in time but vary over time. Examples of these effects are factor prices, the increased availability of new technology over time and the effect of interstate price cap regulation. The γ_i are firm specific effects. These variables control for unobservable, firm-specific effects that are constant over time: e.g., average output growth rates, density of population in the service territory, initial degree of modernization. Ordinary least squares techniques can be applied directly to equation (1) to obtain an unbiased estimate of the coefficient measuring the effect of incentive regulation on the index.

There are three problems which arise in trying to estimate the model as currently formulated. First, the economic choice between technologies is driven largely by factor prices (as it should be),[4] but factor prices are notoriously difficult to measure accurately. In particular, the rental price of capital for old and new technologies is clearly important, but available measures of equipment prices--telephone price indices (TPIs)--do not adjust for quality of the equipment. To avoid this problem, we eliminate factor prices from the estimating equation by transforming the data into

[3]For example, y might index the fraction of total lines served by digital switches.

[4]In this context, relative factor prices include the relative prices of modern and conventional equipment.

deviations from firm means (over time), or, equivalently, by including a full set of indicator variables for years. Under the assumption that factor prices are identical for all firms at the same point in time, these indicator variables completely absorb the effect of factor prices on modernization.[5]

The second problem is the question of causality. Applying single equation estimation methods to equation (1) requires that factor prices and our measures of incentive regulation be exogenous. Certainly it is reasonable to assume that telephone companies are price-takers in the capital, labor, and raw materials markets, but it is less reasonable to assume that the condition of regulation in a state is determined independently from its level of modernization. The determinants of the demand for regulation are discussed in the emerging economic literature on the political causes of regulatory policy, stemming largely from George Stigler's seminal work in the early 1970s.[6] While precise models do not emerge from this literature, it is clear that the level of modernization of a state's telecommunications infrastructure could affect the demand for regulatory reform. And if it does, application of single equation estimation techniques to equation (1) will produce biased results. The relationship between the degree of incentive regulation and the extent of modernization includes two components working in opposite directions: (i) incentive regulation increases the degree of modernization by improving incentives to innovate and invest, and (ii) as the degree of modernization increases, the need for ameliorative incentive regulation declines.

If random disturbances shift the demand curve for regulation relative to the curve which depicts the effect of incentive regulation on modernization, then observations on modernization-regulation pairs will trace out the effect of regulation on modernization. If the determinants of modernization shift relative to the demand for modernization, observations on modernization and regulation will identify the demand for regulation. In a single cross-section of data, we cannot tell

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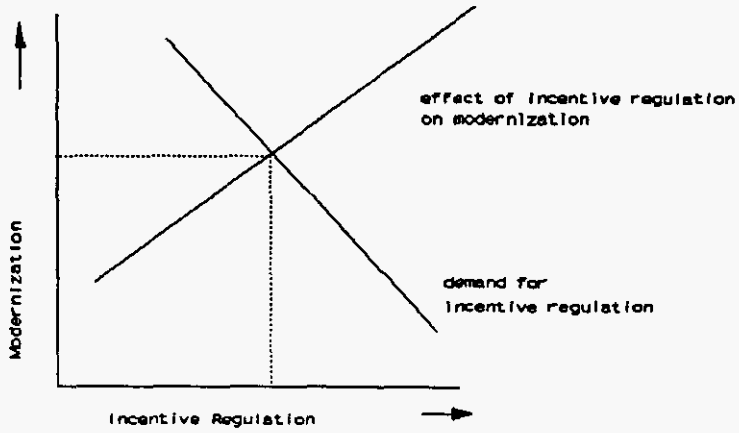
[5]Time indicator variables also sweep out any other unmeasured variables which are constant across firms at any point in time but which vary over time. The increased availability of new technology over time is such an unmeasured variable, as is the effect of interstate price cap regulation.

[6]G.J. Stigler, "The Theory of Economic Regulation," Bell Journal of Economic and Management Science, Vol. 2, (1971), pp. 3-21. A survey of the recent literature is contained in R. Noll, "The Politics of Regulation," in the Handbook of Industrial Organization, (R. Schmalensee and R. Willig, eds.), New York: North-Holland Press, 1989, Chapter 22.

from the data which relationship (or what combination of both relationships) we are estimating.

Figure 1.
Supply of Modernization
and
Demand for Regulation



Panel data--observations on many firms at different points in time--can solve this problem. It is reasonable to assume that the demand curve for regulation is relatively fixed in time, so that while it varies across states (depending, in part, on the condition of the infrastructure in each state), it is relatively constant within a state over time. In other words, the determinants of the degree of incentive regulation adopted in a particular state (which include the condition of the infrastructure) are largely state-specific and time-invariant. Using panel data, these unmeasured effects can be eliminated by transforming the data into deviations from time averages (within a firm) or, equivalently by including a full set of firm specific indicator variables.[7] At the same time, all other firm-specific (or state-specific) unmeasured effects--average output growth rates, density of population in the service territory, initial degree of modernization, etc.--are controlled for using these techniques.

The third problem in estimating our model is that another major change in the local exchange landscape is occurring at the same time as regulatory reform: intraLATA markets are being opened to competitive entry. Indeed, part of the reason for adoption of incentive regulation is the realization that traditional rate of return regulation of an historically dominant firm in a newly competitive market may be worse than either no regulation or no competition. If increased competition leads (i) LECs to modernizes their networks more rapidly, and (ii) LECs and regulators to

[7]See J.A. Hausman and W.E. Taylor, "Panel Data and Unobservable Individual Effects," Econometrica, 49 (1981), pp. 1377-1398.

adopt incentive regulation, then a statistical relationship between modernization and incentive regulation may be misleading. An observed association might occur only because both modernization and incentive regulation are simultaneously affected by an unobserved common factor: increased competition. To control for this possibility, we include two measures of intraLATA competition as explanatory variables: for a given state and year, whether or not (i) facilities-based competition is permitted, or (ii) reseller-based competition is permitted.

B. The Data

To estimate the parameters of equation (1) above, we require measures of modernization for each firm and each year and indicators of the presence or absence of different forms of incentive regulation, as applied to each firm for each year. The final sample consists of data on 21 (former) Bell operating companies from 1980 to 1994.

Modernization data were taken from LEC filings (and updates) in the 1990 federal rate of return represcription docket for the local exchange carriers.[8] These data consist of actual and estimated levels of switching equipment and interoffice and loop transmission facilities by technology for the period 1980 to 1994. Data through 1989 represents observed levels of new technology and 1990-1994 represent company estimates of future levels. We observed data on the fraction of access lines connected to digital switching facilities, the fraction of lines from which SS7 and ISDN services can be provided, and the fraction of fiber-optic lines. The dependent variables in the regressions were the natural log of the ratios of new technology to old technology.[9]

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[8]Federal Communications Commission, In the Matter of Represcribing the Authorized Rate of Return for Interstate Services of Local Exchange Carriers, CC Docket 89-624.

[9]This specification is consistent with a Bass-type diffusion model for new technology. The fraction of equipment embodying new technology (denoted $P_{i,t}$) is related to the index by $P_{i,t} = \frac{1}{1 + \exp(-y_{i,t})}$.

Information on the type of regulation for each firm for each year was taken from an earlier study[10] and updated using information gathered from state regulatory agencies, telephone companies, and the February 21, 1991 State Telephone Regulation Report compilation of local telephone company incentive regulation plans. Plans were divided into seven categories: none, banded rate of return regulation, rate of return sharing plans, flexible pricing, indexed price caps, negotiated social contracts, and deregulation. In addition, a single indicator variable indicating the presence of any form of incentive regulation was constructed for each combination of year and firm. The dates on which each plan became effective for each company were noted, and an indicator variable for each type of incentive regulation was constructed which took on the value "1" for company *i* in year *t* if the form of regulation in question were in effect for that firm and year combination. Similar data was obtained from the same sources regarding the status of facilities-based and reseller competition in the intraLATA market. Modernization data for some firms were available only on a multi-state basis, and a line-weighted average of the regulation data for those firms was constructed.

C. The Results

In general, modernization for most measures of infrastructure increases significantly with the adoption of any form of incentive regulation. Using a single indicator of regulatory reform, all coefficient estimates were positive and only the coefficient in the ISDN equation was not statistically significant. Table 1[11] summarizes the results of the analysis for an aggregate measure of the adoption of incentive regulation. Between 1991 and 1992, an average firm experiences increases in its modernization indices by the amounts given in column (3). Adoption of incentive regulation in 1991 increases the modernization indices in 1991 by the amounts given in column (4). Thus digital switching and fiber transmission indices are accelerated in the first year by approximately 11 months by the adoption of incentive regulation. ISDN and SS7 development is increased by about 5 months in

[10]W.E. Taylor, "Incentive Regulation in Telecommunications," filed on behalf of New England Telephone & Telegraph Company in State of Maine Public Utilities Commission (Docket No. 89-397), June 11, 1990.

[11]Standard errors are presented in parentheses. Degrees of freedom range from 120 to 273.

Table 1
The Effects of Incentive Regulation
on Modernization
(standard errors)

	Coefficient of 1991 Effect (1)	Coefficient of 1992 Effect (2)	Change in Modernization Index: (2) - (1) (3)	Coefficient of Incentive Regulation (4)	Months Modernization is Advanced (5)
Digital Switching	-0.3104 (0.2009)	-0.1153 (0.1987)	0.1951 (0.2826)	0.1748 (0.0432)	11
Fiber Transport	-0.5731 (0.1717)	-0.3633 (0.1691)	0.2098 (0.2410)	0.1989 (0.0416)	11
ISDN Technology	-0.9429 (0.3356)	-0.6500 (0.3184)	0.2929 (0.4626)	0.1110 (0.1189)	5
SS7 Technology	-1.2770 (0.3265)	-0.7640 (0.3088)	0.5130 (0.4494)	0.2226 (0.1268)	5

the first year. In future years, the difference in the level of modernization widens. Figures 2, 3, 4, and 5 show the estimated effects of incentive regulation on the diffusion of new technology for an average firm which experiences a change from rate of return to incentive regulation.

The effect of intraLATA competition on these results is small. Facilities-based competition affects modernization only for fiber and ISDN; the negative coefficient implies slower implementation of these technologies when the intraLATA market is opened to competition. Table 2 shows that the effect of incentive regulation on modernization is statistically unchanged when we control for the introduction of competition.

V. Conclusions

Proponents of incentive-compatible forms of regulation frequently use the need to modernize the U.S. telecommunications infrastructure as a reason for adopting incentive regulation plans. Theoretical support for this relationship is sketchy, as is information on the effects of regulation on research and development and on the rate of diffusion of new technology. From the sample of local exchange carrier

Table 2
The Effects of Competition and Incentive Regulation on Modernization
(standard errors)

	Basic Models	Models With Facilities Based Competition Variable		Model With Reseller Competition Variable	
	Coefficient Of Incentive Regulation	Coefficient Of Incentive Regulation	Coefficient Of Competition	Coefficient Of Incentive Regulation	Coefficient Of Competition
Digital Switching	0.1748 (0.0432)	0.1688 (0.0436)	0.0364 (0.0340)	0.1684 (0.0435)	0.0939 (0.0801)
Fiber Transmission	0.1989 (0.0416)	0.2101 (0.0408)	-0.0979 (0.0313)	0.1983 (0.0415)	-0.1084 (0.0866)
ISDN Technology	0.1110 (0.1189)	0.1336 (0.1104)	-0.3953 (0.0904)	0.1050 (0.1184)	-0.2838 (0.1982)
SS7 Technology	0.2226 (0.1268)	0.2270 (0.1275)	0.0600 (0.1070)	0.2513 (0.1269)	0.3515 (0.2166)

data used, we find that the proportion of switching and loop transmission facilities which are modern is higher for those companies and time periods for which incentive regulation plans are in effect. For ISDN and SS7 service platforms, the evidence is weaker but also suggests a positive association between regulatory reform and modernization. In the aggregate, the adoption of some form of incentive regulation for one year advanced switching and transmission modernization by roughly a year and ISDN and SS7 modernization by about six months.

These results are, of course, preliminary. They are based on a particular sample of modernization data, half of which (1990-1994) are based on forecasts and on our own idiosyncratic categorization of state regulatory decisions. Nonetheless, the trends seem consistent in various specifications of the relationships, and it appears likely to us that these results reflect aspects of actual firm behavior in response to different regulatory regimes.

Figure 2.
The Effect of Incentive Regulation on the Diffusion of Digital Switching For An Average LEC

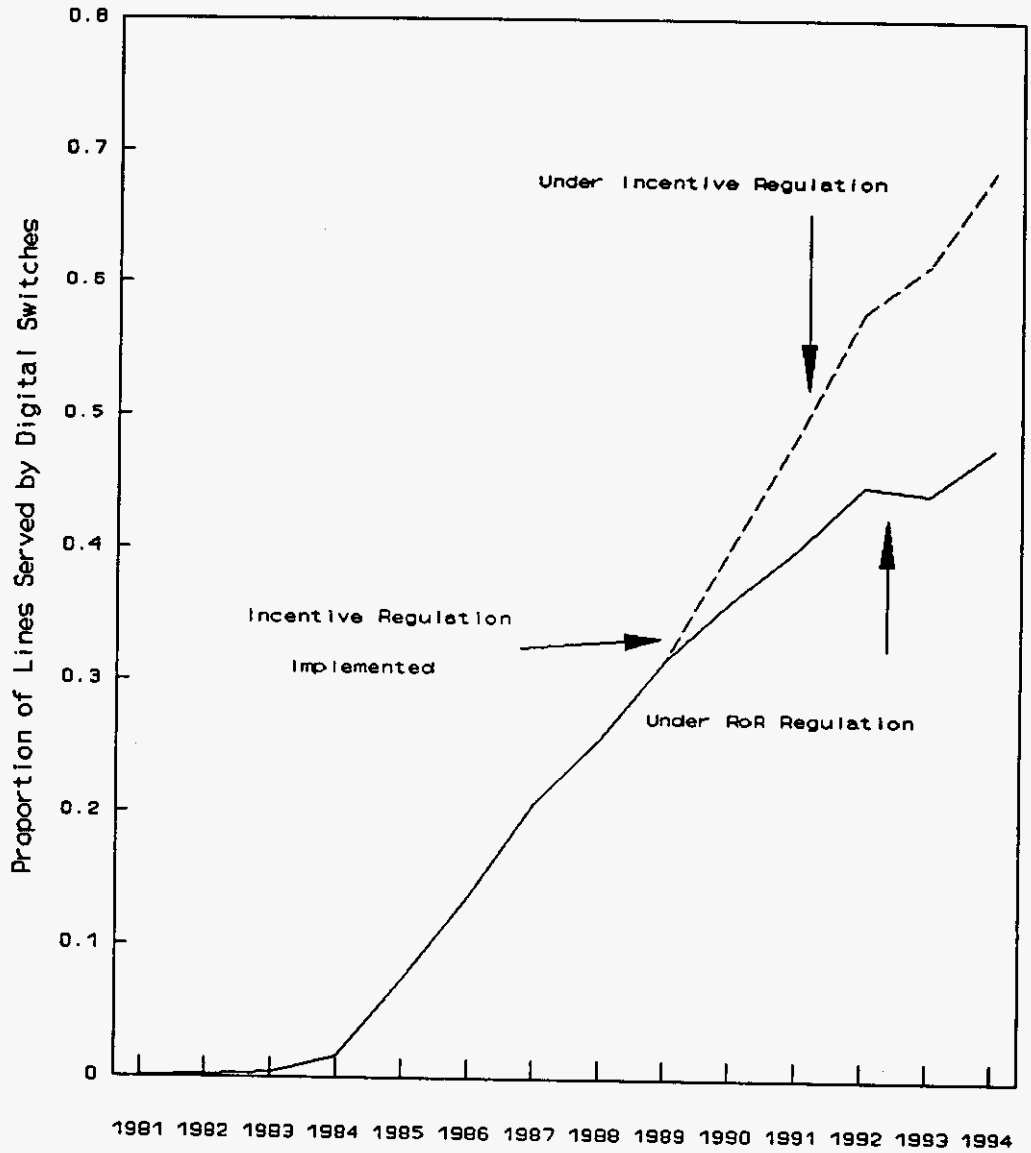

Figure 3.
The Effect of Incentive Regulation on the Diffusion of Fiber Technology for an Average LEC

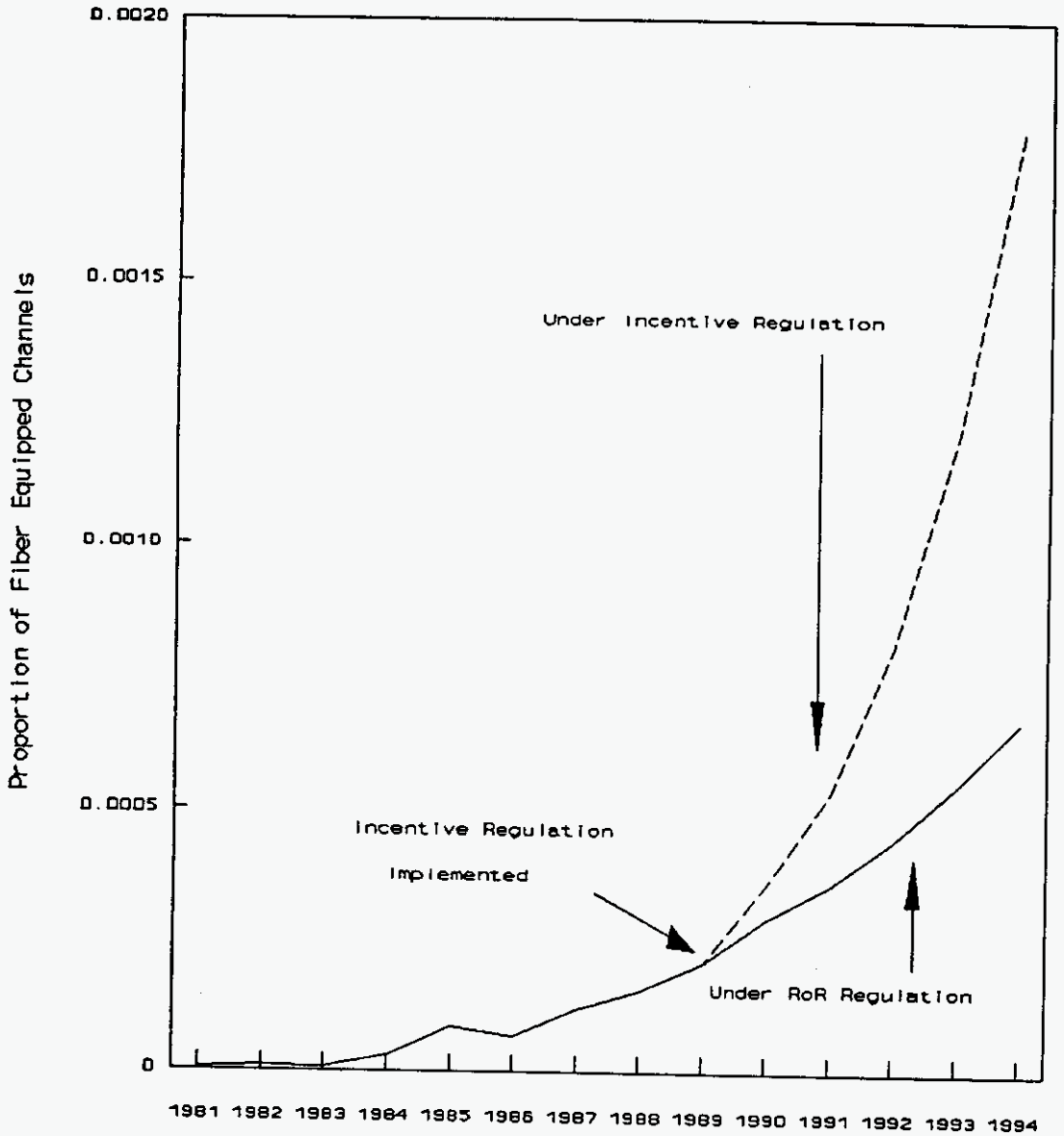

Figure 4.
The Effect of Incentive Regulation on the Diffusion of SS7 Technology for an Average LEC

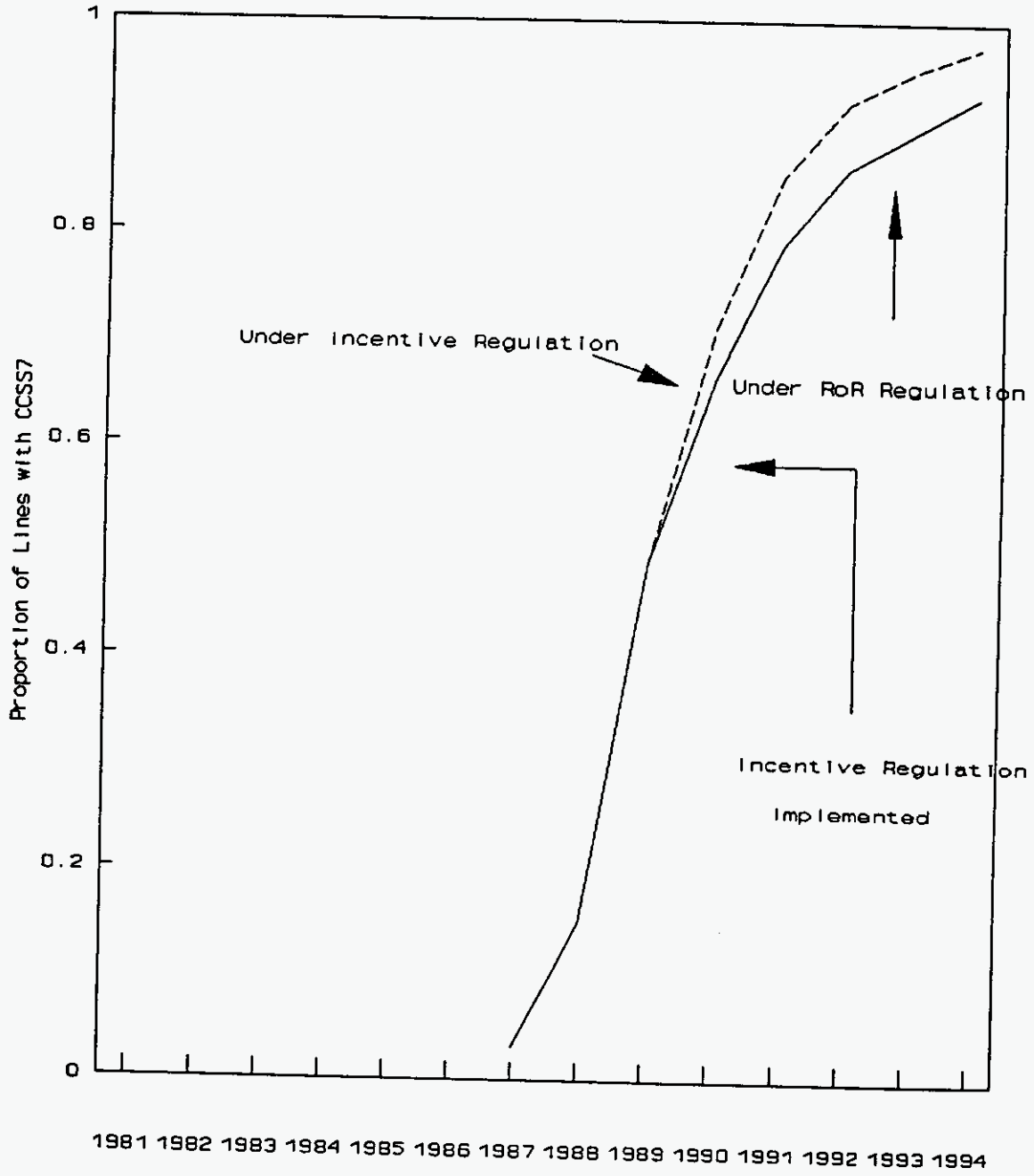

Figure 5.
The Effect of Incentive Regulation on the Diffusion of ISDN Technology for an Average LEC