LOCAL TELEPHONE QUALITY-OF-SERVICE:
THE IMPACT OF REGULATION AND COMPETITION

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
Michael Edward Clements, B.B.A., M.P.A.

* * * * *

The Ohio State University
2001

Dissertation Committee:
Dr. Douglas N. Jones, Advisor
Dr. Anand Desai
Dr. Raymond W. Lawton

Approved by

[Signature]
Advisor
School of Public Policy and Management
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2001
Changes in market structure and regulation are creating an important transition in the local telephone industry. A dominant firm - competitive fringe market structure is replacing the traditional monopoly market structure while state regulators increasingly rely on alternative regulation in place of traditional rate-of-return regulation. At the same time, quality is important and shows signs of decline. However, no theoretical or empirical literature addresses quality in a transitional market structure with regulation.

The theoretical component begins with a framework of quality that distinguishes between equipment and system oriented quality and people and process oriented quality. Next, I extend the existing literature on quality in a monopoly environment with regulation. In price - quality space, I find that regulation directly influences the monopolist's quality. Importantly, price cap and rate freeze regulation are associated with lower quality. Finally, I develop a theory of quality in a dominant firm - competitive fringe environment with regulation. I compare the unregulated monopoly and dominant firm - competitive fringe outcomes and I compare the unregulated and the regulated dominant firm - competitive fringe outcomes. In both instances, I find the outcome depends on the nature of the competitors' products or services and the nature and stringency of regulation.
The theoretical component provides a framework and hypotheses for the empirical analysis of local telephone quality-of-service. I develop a panel dataset consisting of the largest local telephone company in each state for 1991 through 1999. I first examine the trends in quality-of-service, where seven of eight quality measures indicate decline. Next, I conduct regression analysis on quality-of-service in monopoly markets. The regression results indicate that quality-of-service declines with price cap/rate freeze regulation and deregulation. Next, I conduct regression analysis on quality-of-service in dominant firm - competitive fringe markets. The regression results indicate that competition and regulation have a mixed impact on quality-of-service. Finally, I examine whether investment in modern infrastructure, corporate merges, and labor unrest influence quality-of-service.
Dedicated to my mother,
Carlene Clements
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VITA

October 2, 1966 ........................................... Born - Cincinnati, OH

December 1989 ........................................ B.B.A.,
University of Cincinnati,
Cincinnati, OH

1990 - 1994 ........................................... Financial Consultant,
AT&T Global Information Solutions,
Dayton, OH and Rockville, MD

June 1997 ............................................. M.P.A.,
The Ohio State University,
Columbus, OH

1995 - 1999 ........................................... Graduate Research Associate,
The National Regulatory Research Institute,
Columbus, OH

1999 - present ...................................... Senior Telecommunications Policy Analyst,
U.S. General Accounting Office,
Washington, DC

PUBLICATIONS


FIELDS OF STUDY

Major Field: Public Policy and Management

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             Industrial Organization
             Public Finance
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CHAPTER 1

INTRODUCTION

Changes in regulation, market structure, and technology are creating an important transition in the local telephone industry.¹ With regards to regulation, state public utility commissions are increasingly adopting alternative regulatory regimes for local telephone companies to replace traditional rate-of-return regulation. These alternative regulatory regimes assume a variety of forms, including earnings sharing, price cap, and rate freeze regulation. With regards to market structure, a dominant firm and competitive fringe market structure is slowly replacing the long-standing monopoly market structure. Prior to the Telecommunications Act of 1996 (1996 Act), the monopoly market structure was ubiquitous in the local telephone industry. The 1996 Act encourages competitive entry through a variety of means. Finally, technological advances continue to reshape the local telephone industry. Digital technology is widespread in the local telephone industry, with

¹ Similar transitions are underway in other public utility industries, including the electric and natural gas industries.
applications in switching and advanced telephone services such as digital subscriber line. Fiber optic cable is also becoming increasingly prevalent. Both digital and fiber optic technologies facilitate advanced telephone services.

Quality-of-service is an important aspect of local telephone service and is showing signs of decline. In the local telephone industry, quality-of-service is a function of both the telephone network itself and installation, maintenance, repair, and other support services. As society increasingly relies on local telephone service for commercial and emergency communications, quality-of-service will become increasingly important. Viable commercial and emergency services require high quality local telephone service. Without high quality local telephone service, commercial transactions will be missed and emergency services will not be forthcoming. However, concerns exist regarding the level of local telephone quality-of-service. These concerns emerged in the late 1970’s and the early 1980’s. Carron and MacAvoy (1981) report on the decline in quality-of-service in the telephone industry, as well as other public utility industries. The authors indicate that regulation, rate-of-return regulation at this time, contributed to the decline in service in the 1970’s. Interestingly, recent concerns about quality-of-service accompany the transition from rate-of-return regulation to alternative regulation. Perhaps the most well-known

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2 Harris and Kraft (1997) refer to telecommunications as a “strategic sector,” one where the contribution to social welfare exceeds the private returns to shareholders and direct consumers. The excess returns to social welfare arise because the telecommunications sector facilitates productivity in many other sectors that rely on its services.

3 According to the authors, the high rates of inflation in the 1970’s, combined with the failure of state public utility commissions to adjust rates adequately, reduced firms’ incentives to invest in quality-of-service.
example is the state of Oregon’s experience with alternative regulation. The Public Utility Commission of Oregon adopted an alternative regulation plan in 1991 for US West, the largest local telephone company in Oregon, only to terminate the plan in 1996 because of “a severe increase of service quality problems, relating to both customer service and technical service.”

Because of the importance of local telephone quality-of-service, problems that arise from industry transition in regulation and market structure pose important challenges.

The transition underway in the local telephone industry poses theoretical and empirical questions concerning quality-of-service. Beginning in the 1970’s, the subject of quality in a monopoly environment began to appear in the literature. This literature focuses on the deviation of a monopolist’s choice of quality from the level of quality that maximizes social welfare. This literature provides insights for the traditional monopoly local telephone market structure. However, Chessler (1996) notes that “there have been no systematic studies of the relationship between the level of quality and the degree of competition.” This is an important observation given the transition underway in the local telephone industry. Some recent literature addresses quality in duopoly and oligopoly market environments. However, no literature addresses quality in markets characterized by a dominant firm and competitive fringe. Thus, no theoretical or empirical research exists that addresses quality in a market environment consistent with the local telephone industry and other public utility industries.

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5 Chessler (1996), 14.
With this dissertation, I begin to fill the void in the theoretical and empirical literature. Three major research questions motivate the analysis. First, how will regulation influence quality in a monopoly environment? Second, how will quality differ in a monopoly environment compared to a dominant firm - competitive fringe environment? Third, how will regulation influence quality in a dominant firm - competitive fringe environment? I employ a theoretical and empirical analysis to address these three research questions. To begin, I propose a framework of quality that provides insights for and guides the theoretical and empirical analysis. In the framework of quality, I classify quality by (1) the nature of the service and (2) the evaluation of the service. I follow the framework of quality with a theoretical analysis of quality, broadly defined, in both a monopoly environment and a dominant firm - competitive fringe environment. I extend the literature that addresses quality in a monopoly environment by incorporating regulation prevalent in the local telephone industry. Specifically, I examine quality in a monopoly environment with regulation in price - quality space. I extend the dominant firm - competitive fringe literature by incorporating quality and regulation. Again, this entails examining quality in a dominant firm - competitive fringe environment, as opposed to a monopoly environment, with regulation in price - quality space. To complete the analysis, I empirically test the theoretical predictions with data from the local telephone industry. I develop a panel dataset which includes eight measures of quality for the largest local telephone company in every state, excluding Alaska, for the period 1991 to 1999. With the panel dataset, I conduct a variety of statistical tests of local telephone quality-of-
service in both monopoly and dominant firm - competitive fringe environments. Thus, through the theoretical and empirical analysis, I begin to address a current void in the literature and provide important information to state and federal regulators.

In a monopoly environment, I find that regulation influences a monopolist’s choice of quality. In the theoretical analysis, the specific outcome depends on the type of regulation imposed and nature of demand. Assuming a common demand structure, I find that price regulation will induce lower quality while rate-of-return and quality regulation will induce higher quality than the unregulated monopolist’s choice of quality. In the empirical analysis, the regression results for the local telephone industry confirm the theoretical predictions. When the local telephone company is subject to price cap or rate freeze regulation, two common forms of price regulation, or deregulation, local telephone quality-of-service is generally lower than when the local telephone company is subject to rate-of-return regulation. This analysis addresses the first research question.

In the dominant firm - competitive fringe environment, I find mixed results for the dominant firm’s choice of quality. In the theoretical analysis, I find that the specific outcome depends on (1) the nature of the competitors’ substitute products or services, (2) the amount of competition, and (3) the nature and stringency of regulation. These three factors jointly determine whether competition, regulation, or both influence the dominant firm’s choice of quality. In the unregulated dominant firm - competitive fringe environment, the presence of a low quality substitute induces the dominant firm to

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6 In this demand structure, inframarginal consumers’ willingness to pay for quality exceeds the marginal consumer’s willingness to pay for quality. Both this and the opposite scenario are examined in chapter 4.
improve quality vis-à-vis the monopolist. However, the dominant firm’s quality is lower than the monopolist when a high quality substitute is present and the results are unclear when both low and high quality substitutes are present. In the regulated dominant firm-competitive fringe environment, the results are more convoluted. With price regulation, the dominant firm’s quality declines vis-à-vis the unregulated position with a low quality substitute while the outcome is uncertain with a high quality substitute. With quality regulation, the dominant firm’s quality is higher than the unregulated position with a high quality substitute while the outcome is uncertain with a low quality substitute. Finally, with rate-of-return regulation, the dominant firm’s quality improves vis-à-vis the unregulated position with a high quality substitute while the outcome is uncertain with a low quality substitute. In the empirical analysis, the regression results mirror the uncertainty in the theoretical analysis. Specifically, neither regulation nor competition are consistently associated with improved or lower quality-of-service in local telephone markets characterized by the dominant firm-competitive fringe market structure. This analysis addresses the second and third research questions.

The remainder of this dissertation consists of the following. In chapter 2, I provide a brief history of the telephone industry and its regulation. This chapter provides the necessary background information and context for the subsequent theoretical and empirical analyses. In chapter 3, I examine the various definitions of quality and propose a framework for examining quality in the local telephone industry. The framework of quality provides important insights on quality that guide the theoretical and empirical analysis. In chapter 4, I present the theoretical analysis of quality in both a monopoly and
dominant firm - competitive fringe environment. In both instances, I incorporate regulation to examine a mixed market structure that typifies the local telephone and other public utility industries. In chapter 5, I test the theoretical predictions with an empirical analysis of local telephone quality-of-service. I begin by examining the trends in quality-of-service through the 1991 to 1999 period. I follow this with regression analyses of both monopoly and dominant firm - competitive fringe market structures. I also consider the impact of modern infrastructure deployment, corporate mergers, and labor strife on local telephone quality-of-service. Finally, I conclude in chapter 6 with a summary of the major theoretical and empirical contributions and the policy implications of the research.
CHAPTER 2

A BRIEF HISTORY OF THE TELEPHONE INDUSTRY AND ITS REGULATION

In this chapter, I discuss (1) the history of the telephone industry, (2) two categories of regulation relevant to state public utility commissions and the local telephone industry, and (3) four theories that attempt to explain the origin of and rationale for regulation and the behavior of regulators. For much of the nineteenth and twentieth centuries, a vertically integrated AT&T dominated the telephone industry. The Modification of Final Judgment in 1984 facilitated competition in the long distance and the equipment markets and the Telecommunications Act of 1996 encouraged competition in local telephone markets. As a result, a dominant firm and competitive fringe market structure is slowly replacing the long-standing monopoly market structure in the local telephone industry. There are two major categories of regulation: economic regulation and social regulation. Economic regulation addresses market failures arising from market power and includes rate-of-return regulation and various forms of alternative regulation. Social regulation addresses market failures arising from externalities and public goods and includes quality-of-service regulation. The theories of regulation also fall into two broad categories: institutional-based theories and public choice-based theories. The institutional-
based theories consist of the public interest and equity-stability theories. The public choice-based theories consist of the capture and interest group theories. A discussion of the history, categories of regulation, and theories of regulation is important for establishing a context into which this dissertation fits and introducing concepts that enter into the theoretical and empirical analyses to follow.

2.1. A Brief History of the Telephone Industry

For the first seventeen years of existence, the telephone industry functioned as a monopoly. This monopoly was the product of U.S. Patent Number 174,465, awarded to Alexander Graham Bell on March 7, 1876. Shortly after Bell’s introduction of telephone service, Western Union, the nation’s dominant telegraph company, entered into competition with Bell, developing telephone exchanges under the patents of Elisha Gray and Thomas Edison. Bell subsequently filed a patent infringement suit against Western Union. In a voluntary settlement, Western Union acknowledged the validity of Bell’s patents and agreed to withdraw from the telephone business while Bell agreed to

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7 There are many books that trace the history of the telephone industry. I rely principally on Phillips (1993) for this discussion, with additional support from Irwin (1984), Teske (1990), and U.S. General Accounting Office (2000A).

8 There is controversy regarding the awarding of the telephone patent to Alexander Graham Bell. Elisha Gray filed a similar patent for a telephone devise on the same day as Bell and uncertainty surrounds which patent application was received first and whether Bell was given the opportunity to review Gray’s patent application (Irwin 1984).
withdraw from the telegraph business. In essence, this voluntary settlement created a monopoly in the telephone industry and a dominant firm without significant competition in the telegraph industry.

In the 1880’s, Bell and his financial partners organized their companies into the American Telephone Company, later called AT&T. American Telephone Company engaged in four principal activities. First, the company provided local telephone service through license agreements with local operating companies, in return for equity interest in the companies. Second, the company provided long distance service between the local telephone operating companies. Third, the company manufactured telephones and telephone-related equipment. This was made possible by American Telephone Company’s acquisition of Western Electric Manufacturing Company, the premier manufacturer of telephones and telephone-related equipment (Irwin 1984). Western Electric Company became American Telephone Company’s telephone and telephone-related equipment manufacturing division. Fourth, the company started Bell Laboratories, a division that conducted research and development.

Following the expiration of the Bell patent in 1894, many independent telephone companies emerged in the telephone industry. These independent telephone companies were now free to enter the telephone industry without the fear of a Bell patent infringement suit.⁹ In many instances, these independent telephone companies entered into direct competition with AT&T. Of 1,002 cities with telephone service in 1902, 414 cities

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⁹ According to Irwin (1984), AT&T filed over 600 patent infringement suits in the 1880’s alone.
were served only by a Bell company, 137 cities (mainly smaller cities in rural areas) were served only by independent companies, and 451 cities were served by both a Bell company and one or more independent companies (Phillips 1993, 752). By 1907, these independent telephone companies, numbering approximately 8,000, provided just over 50 percent of the local telephone service in the United States (U.S. General Accounting Office 2000A, 6). The largest independent telephone company was General Telephone Corporation, later called GTE.\footnote{In 1999, GTE was the fifth largest telephone company in the United States with $25.3 billion in revenue and 99,000 employees. It was the third largest local telephone company. However, prior to the merger of Southwestern Bell, Pacific Telesis, and Ameritech and the merger of Bell Atlantic and NYNEX, GTE was the largest local telephone company. In 2000, GTE was purchased by the combined Bell Atlantic and NYNEX, with the new company renamed Verizon. FCC (2000)}

In response to the emergence of the independent telephone companies, AT&T began an aggressive campaign to eliminate these competitors in 1907. AT&T’s strategy included (1) acquiring the independent telephone companies, especially those in direct competition with a Bell local telephone operating company in the largest cities,\footnote{This pattern of acquiring independent telephone companies in large cities explains why the Regional Bell operating companies, discussed below, are the primary providers of local telephone service in America’s largest cities.} (2) refusing to allow independent telephone companies to interconnect with AT&T’s larger network,\footnote{In a network industry, the tendency for consumers to migrate towards a larger network, because of positive network effects, can cause an industry to “tip” from competitive to monopoly as the value of the larger network increases with every consumer switching. According to Robinson (2000), “the possibility of obtaining significant and sustained market power creates an incentive for a firm to engage in predatory behavior to create a tipping effect . . . [including] degrading its rivals’ access to its network. By denying compatibility, a larger firm will have less to lose by decreasing compatibility than rival firms; the value of the rivals’ networks will decrease more than the value of the larger firm’s network.”} and (3) reducing prices in markets directly threatened by competition. In addition, AT&T acquired a substantial ownership interest in Western Union. These
aggressive tactics, and especially the acquisitions of direct competitors, encouraged the Department of Justice to initiate an antitrust suit against AT&T. In 1913, AT&T entered into a voluntary settlement with the Department of Justice, called the Kingsbury Commitment. AT&T agreed to (1) sell its ownership interest in Western Union, (2) stop acquiring independent telephone companies that competed against AT&T, and (3) interconnect with the independent telephone companies.

During these early years, local and state officials predominately regulated the telephone industry. Local government officials regulated local telephone service through the awarding of municipal franchises. The telephone company received permission to use the public right-of-way to install its telephone lines and equipment in return for accepting the terms and conditions imposed by the local government (Priest 1993). However, “there is substantial evidence of persistent difficulties relating to specifying the franchise contract, adapting it over time to new conditions, and monitoring compliance with the contract for the benefit of the citizenry.”  

These problems with municipal franchise contracts, combined with telephone companies’ expansion beyond local government boundaries, induced state governments, through public utility commissions, to assert authority over the intrastate telephone industry. The expressed intent of telephone regulation by state public utility commissions was to prevent monopoly abuse (Teske 1990). State public utility commissions, which generally consist of a group of commissioners and staff, are typically outside of direct executive and legislative control and typically contain a bipartisan and

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multi-member commissioner structure. According to Reagan (1987), these independent regulatory commissions were an attempt to bring “good government” and “neutral expertise” to regulation, versus the presumed negative influence of politics. These state public utility commissions began regulating the intrastate operations of telephone companies. Federal regulation of the telephone industry began with passage of the Mann-Elkins Act in 1910. The Mann-Elkins Act delegated regulatory powers over interstate and foreign telephone, telegraph, and cable services to the Interstate Commerce Commission. However, the commission engaged in very limited oversight of the telephone industry because of its overriding focus on the railroad industry.

The Communications Act of 1934 established the framework for comprehensive interstate telephone regulation and consolidated federal telephone regulation at the Federal Communications Commission (FCC).\textsuperscript{14} The purpose of the act was to provide for the regulation of “interstate and foreign commerce in communications by wire and radio so as to make available, so far as possible, to all the people of the United States . . . a rapid, efficient, Nation-wide, and world-wide wire and radio communications service with adequate facilities at reasonable charges.”\textsuperscript{15} Phillips (1993) identifies five key components

\begin{footnotesize}
\begin{enumerate}
\item With passage of the Communications Act of 1934, a joint state and federal regulatory structure was formalized. The state public utility commission regulated intrastate telephone service and FCC regulated interstate telephone service. In recent years, Jones (1987) argues that federal regulators are increasingly encroaching on the domain of state public utility commissions.
\end{enumerate}
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of the act. First, common carriers\(^\text{16}\) were required to provide “adequate service” upon “reasonable request.” Second, all rates and practices were to be “just and reasonable.” Third, common carriers were required to obtain a certificate of public convenience and necessity\(^\text{17}\) for the construction, acquisition, or operation of a new telephone line. Fourth, common carriers were required to interconnect with other telephone companies. Finally, FCC could, and ultimately did, require telephone companies to maintain records under a uniform accounting system and submit those records periodically to the commission.

A 1949 civil antitrust suit brought by the Department of Justice was the first challenge to the vertically integrated structure of the telephone industry. AT&T controlled the manufacture of telephones and telephone-related equipment, long distance service, and 80 percent of the local telephone industry.\(^\text{18}\) Western Electric, AT&T’s manufacturing division, manufactured and purchased telephone equipment for the Bell local telephone operating companies, installed telephone systems, and performed repairs. The Department of Justice filed the civil antitrust suit alleging a conspiracy to monopolize the manufacturing, distribution, and sale of telephones and telephone-related equipment. Essentially, the Department of Justice asserted that AT&T, through its control of local

\(^{16}\) A common carrier is a company required to provide service to all consumers seeking service, at reasonable prices and without discrimination (Phillips 1993). AT&T and the independent telephone companies were common carriers. Today, incumbent local exchange carriers, known as ILECs, are common carriers.

\(^{17}\) A certificate of public convenience and necessity is required to provide public utility service (e.g., electric, natural gas, telephone) and is issued by a government regulatory agency. The company must show that the proposed service is required to meet the public’s convenience and necessity. Phillips 1993.

\(^{18}\) AT&T provided monopoly service to 80 percent of the local telephone market. Independent telephone companies provided monopoly local telephone service to the remaining 20 percent of the market.
telephone service and exclusive arrangement with Western Electric, was extending its local telephone monopoly to a monopoly over the manufacture of telephones and telephone-related equipment (Irwin 1984). AT&T entered into a voluntary settlement with the Department of Justice in 1956. As part of the settlement, AT&T agreed that (1) it would grant licenses to other manufactures for its patents, (2) Western Electric would only sell equipment to telephone operating companies, and (3) AT&T and its Bell operating companies would not provide any services other than telephone-related services.

Technology, combined with regulatory and judicial decisions, brought competition to the long distance and equipment markets. By the 1950’s, microwave technology became a viable alternative to wire-based telephone signal transmission. Microwave technology lowered the technological barriers to entry by reducing the sunk investment costs associated with constructing a wire-based telephone network. The Above 890 and Execunet decisions were crucial regulatory and judicial decisions for permitting competing companies to exploit the advances in microwave technology and provide service in competition with AT&T. In the Above 890 decision of 1959, FCC approved a request from companies other than AT&T and the independent telephone companies to provide noncommon carrier (i.e., private) point-to-point microwave service. FCC found that (1) there was sufficient frequency for the service without interfering with the common carriers’ microwave service, (2) there was a need for private point-to-point service, and (3) competing companies providing the service would not adversely affect the common carriers’ ability to serve the general public (Phillips 1993). The Execunet decision concerned expanding the microwave service from private point-to-point service to public
switched service in direct competition with AT&T. Unlike the Above 890 decision, FCC attempted to block expansion of the competing services. The commission rejected a Microwave Communications, Inc., later called MCI, tariff request for switched service saying that it exceeded the point-to-point service offering approved previously. This decision was later overturned in court. Next, the commission ruled that AT&T did not have an obligation to interconnect with MCI for switched service. Again, the decision was later overturned in court. The result of the Above 890 and Execunet decisions, and the court challenges, was the introduction of competition into the long distance market. In a like manner, the Carterfone decision, in which FCC permitted the attachment of non-telephone company supplied equipment to the telephone network, introduced competition into the telephone equipment manufacturing market.

The Modification of Final Judgment substantially shaped the telephone industry seen today. In 1974, the Department of Justice filed another civil antitrust suit against AT&T. According to the Department of Justice suit, AT&T disadvantaged competitors in both the long distance and equipment markets through its control of local telephone operating companies. In 1982, the parties entered into a voluntary settlement, called the Modification of Final Judgment because it represented a modification of the 1956 consent decree. There were four important outcomes from the Modification of Final Judgment (U.S. General Accounting Office 2000A). First, AT&T was required to divest its 22 local telephone operating companies. These 22 local telephone operating companies were organized into seven Regional Bell operating companies: NYNEX, Bell Atlantic, BellSouth, Ameritech, Southwestern Bell, U S West, and Pacific Telesis. With
divestiture, AT&T could no longer use its monopoly control over local telephone service to maintain a dominant position in the long distance and manufacturing markets. Second, the line of business restrictions imposed on AT&T in the 1956 consent decree were lifted (i.e., AT&T could engage in non telephone-related businesses). Third, there were line of business restrictions placed on the Regional Bell operating companies. These companies were permitted to provide only local telephone service and prohibited from providing long distance and information services and from manufacturing equipment. These restrictions were intended to prevent another vertically integrated situation from arising. Finally, 161 local access and transport areas (LATA) were defined. These areas served as the demarcation point between local telephone service provided by the Regional Bell operating companies (intraLATA service) and long distance service provided by AT&T and other long distance carriers (interLATA service). According to Crandall and Waverman (1995), the Modification of Final Judgment created a “balkanized” telephone industry in the United States.

Prior to passage of the Telecommunications Act of 1996, the telephone industry consisted of modestly competitive long distance and equipment markets and virtual monopoly local telephone markets. In the long distance market, AT&T, MCI, and Sprint were, and still remain, the leading carriers. Since the Modification of Final Judgment,

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19 These line of business restrictions did not apply to the independent telephone companies, which were not defendants in the civil antitrust suit.

20 Taylor and Zona (1995) find that pricing evidence from the interLATA market is “more consistent with noncompetitive behavior.” The authors reach this conclusion by examining the relationship between carrier access charges, fees paid by long distance companies to local telephone companies, and long distance retail rates.
AT&T’s share of the long distance market has declined continuously, from 90.1 percent of total toll service revenues in 1984 to 40.9 percent in 1999 (FCC 2000, Table 1.5). In the equipment market, a variety of companies were and are still providing both telephone system equipment (e.g., switches, fiber optic cables) including AT&T, Nortel, Corning and customer premise equipment (e.g., telephones, facsimile machines, modems, answering machines). However, the local telephone markets remained dominated by the Regional Bell operating companies and independent telephone companies. These local telephone markets were virtual monopolies. In some states, the state public utility commission allowed the presence of competitive access providers (CAP). These companies allowed large business consumers to bypass the local telephone network, and its associated access charges, for long distance service. However, this was not competition for local telephone service. For local telephone service, large business consumers continued to rely on the local telephone company. In addition, some state public utility commissions permitted intraLATA toll competition. Again, this was not competition for local telephone service. Thus, a virtual monopoly market existed for local telephone service.

While the Modification of Final Judgment sought to promote competition in the long distance and equipment manufacturing markets, the Telecommunications Act of 1996 (1996 Act) sought to introduce competition in local telephone markets. The 1996 Act was the first comprehensive revision to the Communications Act since its enactment in 1934. The 1996 Act sought to introduce competition for local telephone service through three modes of competitive entry: resale, access to network elements, and construction of new facilities (U.S. General Accounting Office 2000A). Under resale, competitors
purchase at wholesale rates from incumbent local exchange carriers\textsuperscript{21} local telephone service and resell the service at retail rates. With access to network elements, competitors lease parts of the incumbent’s telephone network, known as unbundled network elements or UNEs, at cost-based rates and either resell the service or combine these elements with their own facilities for retail sale. Finally, competitors are free to construct their own facilities and interconnect these facilities with the incumbent. To implement these market entry goals, the 1996 Act and FCC and state public utility commission regulations conferred rights and imposed obligations on all telephone companies.\textsuperscript{22} At the state level, state public utility commissions (1) approve and reject interconnection agreements between incumbents and competitors, (2) mediate and arbitrate disputes between companies, and (3) implement cost-based prices for interconnection and unbundled network elements. In addition to introducing competition, the 1996 Act is also changing the role of state and federal regulators. According to the U.S. General Accounting Office (2000A), “state and federal regulators recognize their role is changing to become less focused on traditional rate-setting regulation and more focused on mediating disputes among carriers and enforcing laws and regulation.”\textsuperscript{23}

\textsuperscript{21} Incumbent local exchange carriers provided local telephone service prior to passage of the 1996 Act. These companies included the Regional Bell operating companies and the independent telephone companies.

\textsuperscript{22} The market-opening obligations are contained in Section 251 of the Communications Act of 1934, as amended [47 U.S.C. 251].

\textsuperscript{23} U.S. General Accounting Office (2000A), 5.
To date, little competition has emerged in local telephone markets. The U.S. General Accounting Office (2000A) reported that competitive carriers controlled approximately 3 percent of the local telephone market in 1998. However, it also noted that the number of access lines served by competitive carriers has increased rapidly.\(^{24}\) Recent data from FCC illustrate the level of competitive entry into local telephone markets. The number of competitive carriers holding number codes increased from 31 in 1996 to 158 in 1998 nationwide. These same competitive carriers received 4.1 percent of new number codes issued in 1996 and 14.3 percent in 1998 (FCC 2000A, Table 4.1 and Table 4.5).\(^{25}\) Thus, there is growth in the combined number and market share of competitive carriers. However, local telephone markets remain dominated by incumbent local exchange carriers (Vogelsang and Mitchell 1997, 35), as witnessed by the previously mentioned 3 percent market share for competitive carriers. These results imply that there is a transition underway from local telephone markets with a monopoly environment to a dominant firm - competitive fringe environment.

\(^{24}\) This result is not surprising since the competitive carriers are starting from a very small base of access lines.

\(^{25}\) There are no reliable sources providing data on the market share of competitive carriers because these companies are not required to report operating or financial data to FCC or any other government agency. By holding a number code, a competitive carrier has become certified and received a block of numbers to provide service to consumers. While this does not indicate that the company is or ever will provide service, it is the most advanced measure currently available.
2.2. Categories of Regulation

Within the sphere of state public utility commissions and the local telephone industry, there are two categories of regulation. Reagan (1987) defines regulation as "a process or activity in which government requires or proscribes certain activities or behavior on the part of individuals and institutions . . . and does so through a continuing administrative process, generally through specially designated regulatory agencies." Economic regulation addresses market failures arising from market power. Common examples of economic regulation include entry and exit, price, and rate-of-return regulation. Before the mid 1960s, regulation consisted mainly of federal and state government control of entry and prices (i.e., economic regulation) of public utilities (Breyer 1982). Social regulation addresses market failures arising from externalities and public goods. Examples of social regulation include health, safety, and quality.

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26 Reagan (1987), 82.
2.2.1. Economic Regulation

Economic regulation is a response to market failures associated with market power. Among activities generally considered economic regulation, the most common are entry and exit, price, and rate-of-return regulation. With economic regulation, the state or federal regulator attempts to capture the potential production efficiency arising from monopoly supply while promoting allocative efficiency and equity. State public utility commissions traditionally engage in economic regulation of the electric, natural gas, and telephone industries. At the federal level, FCC regulates spectrum allocation and wireless service.

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27 Antitrust policy is another governmental mechanism to remedy market failures associated with market power. However, economic regulation and antitrust policy serve different purposes and are generally not substitutes. Economic regulation is appropriate when the industry under consideration exhibits cost subadditivity (i.e., a single firm can supply the market's demand for output at a lower cost than two or more firms). Economic regulation is used to promote an efficient and equitable outcome with monopoly supply. Antitrust policy is appropriate when the industry under consideration can support market competition. Antitrust policy is used to prevent anticompetitive activities that thwart the benefits of competition.

28 Economic efficiency consists of production and allocative efficiency. With production efficiency, goods and services are produced with the least amount of social resources. In contrast, with allocative efficiency social resources are allocated to their most valued use based on willingness to pay and cost.

29 Neoclassical economic theory has a long tradition in the practice of traditional economic regulation of the public utility industries. This theory is influential in both rate-of-return regulation (e.g., the establishment of an "appropriate" rate-of-return on invested capital) and more recent alternative regulation (e.g., the development of price cap mechanisms). For example, see Trebing (1976) and Bonbright, Danielson, and Kamerschen (1988).
State public utility commissions traditionally engage in vigorous economic regulation of the local telephone industry. Until passage of the 1996 Act, most state public utility commissions controlled entry and exit in the local telephone industry. The state public utility commission action ensured that there would be a single local telephone provider (i.e., there would be no entry). From a normative perspective, this action exploited the cost subadditivity of monopoly supply and allowed a cross-subsidy to maintain basic residential local rates below cost. The firm’s ability to leave the local market was also restricted. With the exception of Nebraska, all state public utility commissions regulate the various prices associated with local telephone service. Some state public utility commissions accomplish this through regulation of the local telephone companies’ rate-of-return on invested capital, while others use one or more of a variety of alternative regulation policies described below. Table 2.1 provides an overview of the trend occurring in economic regulation during the period 1990 to 1998. Because some state public utility commissions use a combination of economic regulatory policies, including some that do not appear in Table 2.1, I select the policy that appears to influence the strategic incentives of the local telephone company the most for inclusion in the table. For example, the California Public Utilities Commission utilizes a combination of

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30 The market-opening obligations contained in Section 251 of the Communications Act of 1934, as amended by the Telecommunications Act of 1996, prohibit state and local policies that restrict entry into local telephone markets [47 U.S.C. 251].

31 The policy of maintaining basic residential local telephone rates below cost is typically justified by reference to the “universal service” goal. While there is disagreement about the initial intent of the term “universal service,” it has come to imply that all citizens desiring telephone service should be able to purchase it (Crandall and Waverman 2000).

32 A complete description of each state public utility commission policy is available in Abel and Clements (1998).
earnings sharing and rate freeze to regulate Pacific Bell. Because the earnings sharing policy appears most prominent, I count California as imposing Revenue/Earnings sharing regulation.

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Source: Abel and Clements (1998)

Table 2.1: Economic regulation policy adopted by state public utility commissions for the largest local telephone company in each state and the District of Columbia for the period 1990 to 1998.

As illustrated in table 2.1, there has been a consistent trend towards the adoption of price cap and rate freeze regulation. The number of state public utility commissions utilizing price cap and rate freeze regulation for the largest local telephone company in each state has increased from three (5.9 percent of commissions) in 1990 to 34 (66.7 percent of commissions) in 1998. State public utility commissions are switching from both rate-of-return, the traditional form of economic regulation, and revenue/earnings sharing,
an early form of alternative regulation. Pricing flexibility is included as a separate category because it is employed by many state public utility commissions (51.0 percent of commissions in 1998) in combination with many of the other policies. Below, I provide a brief description of the various forms of economic regulation used by state public utility commissions for the local telephone industry.

- Rate-of-Return

Rate-of-return regulation is the traditional form of economic regulation used for the local telephone industry. It is an approach where, at the beginning of a given period, regulators determine the firm’s revenue requirement for the period. The revenue requirement is the amount of revenue necessary to “both cover operating costs and provide an opportunity to earn a reasonable rate of return on the property devoted to the business.”\(^{33}\) Algebraically, the revenue requirement can be defined as the following.

\[
R = O + r(V - D) \tag{2.1}
\]

where \(R\) equals the revenue requirement, \(O\) equals the operating costs, \(V\) equals the original cost and improvements of plant and equipment, \(D\) equals depreciation, and \(r\) equals the allowed rate-of-return; \(V - D\) is commonly referred to as the rate base. To

\(^{33}\) Phillips (1993), 176.
implement rate-of-return regulation, the state public utility commission typically initiates a rate case. During the rate case, the state public utility commission must determine (1) the level of operating costs, (2) the dollar value of the rate base, and (3) the allowed rate-of-return. To determine the operating costs and the value of the rate base, the state public utility commission will typically examine the local telephone company’s financial and operating data. According to Bonbright, Danielson, and Kamerschen (1988), the allowed rate-of-return should (1) attract sufficient capital, (2) encourage efficient management practice, (3) promote consumer rationing, (4) ensure fairness to investors, and (5) provide a reasonably stable and predictable rate level to ratepayers. Rate-of-return regulation has been criticized because of perceived production distortions. Because local telephone companies fully recover their operating costs, critics assert that there is little incentive for the firm to reduce operating costs and improve operations. Additionally, Averch and Johnson (1962) show that rate-of-return regulation can induce the local telephone company to overinvest in capital resources.\(^{34}\)

\(^{34}\) The authors compare an unregulated monopolist’s input choice vector (K,L) consisting of capital (K) and labor (L) to a monopolist subject to rate-of-return regulation. They show that the monopolist under rate-of-return regulation has an incentive to shift input resources away from the efficient distribution and towards capital and away from labor.
• Rate Case Moratoria

Rate case moratoria is similar to rate-of-return regulation. Rate case moratoria are agreements between the local telephone company and the state public utility commission to discontinue rate cases, and the accompanying determination of the revenue requirement, for a specific period of time. Thus, the revenue requirement will typically not be adjusted for several years. Rate case moratoria provide the local telephone company with an incentive to initiate short-term strategies to improve earnings, because the company will retain any earnings beyond those typically allowed under rate-of-return regulation during the moratoria period. However, the company has less incentive to make long-term investments because the revenue requirement will eventually be adjusted and "excess" earnings from the investment returned to consumers in the form of lower rates.

• Banded Rate-of-Return

Again, banded rate-of-return is very similar to rate-of-return regulation. However, under this form of economic regulation, the state public utility commission establishes a band, or range, of allowed rate-of-return. For example, if the allowed rate-of-return was previously 10.0 percent, the state public utility commission imposing banded rate-of-return might establish a range of allowed earnings between say 9.0 percent and 11.0 percent. Assuming that the local telephone company's rate-of-return stays within the band, no change in the revenue requirement is initiated. If the band is set narrowly, the strategic
incentives for the local telephone company do not differ significantly from rate-of-return regulation. However, if the band is set widely, the local telephone company is provided with greater incentives to alter its operations because it can keep any “excess” earnings and suffer the consequences of any earnings “shortfall.”

- Earnings and Revenue Sharing

Earnings and revenue sharing are the next incremental step beyond banded rate-of-return. Under banded rate-of-return, earnings outside the band trigger a rate case and an adjustment to the revenue requirement. With earnings sharing, there are ranges of earnings above and below the allowed rate-of-return where “excess” earnings are shared with consumers and earnings “shortfalls” are partially recovered from consumers. For example, consider a 10.0 percent allowed rate-of-return. Earnings between say 9.0 and 11.0 percent would trigger no action; this is consistent with banded rate-of-return regulation. Earnings above 11.0 percent might be shared 50-50 or 75-25 between the consumers and the local telephone company, respectively. Earnings below 9.0 percent might trigger a change in the revenue requirement such that consumers and the local telephone share in the earnings shortfall 50-50 or 25-75, respectively. Revenue sharing operates in a similar manner, with sharing based on actual revenues compared to the revenue requirement. Depending on the width of the bands and the level of sharing, earnings and revenue sharing can provide minimal or large incentives for the local telephone company to alter its strategic operations.
• Price Cap and Rate Freeze

As was illustrated in table 2.1, price cap and rate freeze regulation are currently the most common forms of economic regulation used by state public utility commissions for the economic regulation of local telephone companies. The central concept behind price cap and rate freeze regulation is to control the local telephone company’s price, not its earnings. Once the state public utility commission establishes the initial rate and adjustment factors (for price cap regulation), the local telephone company retains all earnings, whether above or below the traditional allowed rate-of-return, including losses. Because the local telephone company does not share earnings with consumers, the general assumption is that price cap and rate freeze regulation will encourage the company to reduce operating costs and move towards production efficiency.

To implement price cap and rate freeze regulation, the state public utility commission will typically initiate a rate case. The rate case is necessary to establish the initial rate. With a rate freeze, this becomes the rate for a specified number of years. For price cap regulation, the state public utility commission must also select various adjustment factors. Below is a standard formula for the price cap adjustment.

\[ \Delta PC = PI - X \pm Z \]  (2.2)
where $\Delta PC$ is the change in the rate level or price cap, PI is a price index,\textsuperscript{35} $X$ is a productivity offset factor,\textsuperscript{36} and $Z$ is a vector of exogenous factors. The state public utility commission typically adjusts the prior year's rate level, or the initial rate level in the second year, on a yearly basis with the price cap adjustment. For price cap and rate freeze regulation to work properly (i.e., provide incentives for production efficiency and avoid "excess" or "short" earnings), the state public utility commission must correctly set the initial rate level and the productivity offset and choose an appropriate price index and exogenous variables. Any mistake will continue indefinitely and possibly magnify over time without a later adjustment.\textsuperscript{37}

- Social Contract

A social contract, sometimes called a "social compact" or "regulatory bargain," is an agreement between the local telephone company and the state public utility commission regarding special treatment for certain aspects of local telephone service. Each plan is typically unique to the specific company and state. For example, the Vermont Public

\textsuperscript{35} Typical price indices used for local telephone price cap regulation include the Gross Domestic Product, Gross National Product Price Index, and Consumer Price Index.

\textsuperscript{36} The productivity offset factor is included to reduce the rate level by the level of the productivity increase occurring in the telephone industry.

\textsuperscript{37} Helm (1996) refers to adjustments to price cap regulation plans, especially those where earnings appear "excessive," during the period covered by the plan as "regulatory chiseling." If price cap plans are altered frequently due to political pressure, either from consumers and legislatures concerned about "excessive" earnings or the local telephone company concerned about an earnings "shortfall," the incentives provided by price cap regulation will become increasingly similar to those under rate-of-return regulation.
Utilities Commission implemented a plan, referred to as a “Negotiated Social Contract,” for NYNEX, the Regional Bell operating company serving New York and New England, that included a rate freeze on local rates, a price cap on intrastate toll, WATS, and Centrex services, and deregulation of digital data and new services for the period 1988 to 1993. The incentives provided to the local telephone company will vary based on the specific attributes of the social contract.

- Deregulation

As the name implies, this regulatory policy involves the state public utility commission relinquishing control over significant portions of the local telephone company’s pricing and operations. This economic regulatory policy is furthest from rate-of-return regulation regarding the incentives provided to the local telephone company and most closely mirrors an unregulated environment. To date, Nebraska is the only state that has adopted a comprehensive deregulatory policy.38

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38 In Nebraska, all services other than basic local exchange are fully deregulated and earnings are not regulated.
• Pricing Flexibility for Competitive Services

In combination with the regulatory policies mentioned above, many state public utility commissions incorporate some form of pricing flexibility for competitive services. For example, the state public utility commission might classify services as basic or non-competitive and competitive. The local telephone company might be subject to rate freeze regulation for the basic or non-competitive services and be free to change rates as it chooses for competitive services.

2.2.2. Social Regulation

Social regulation "affects the conditions under which goods and services are produced and the physical characteristics of products."[^39] From a normative perspective, social regulation is a response to market failures associated with externalities[^40] and public goods.[^41] State public utility commissions engage in social regulation through quality-of-service policies and consumer education and information programs. At the federal level, examples of social regulation include Federal Trade Commission policies that prohibit


[^40]: An externality occurs when the actions of one economic agent directly affect the environment of another economic agent. Externalities can be either consumption, when the utility of one consumer is directly affected by the actions of another agent, or production, when the production set of one agent is directly affected by the actions of another agent. Varian (1992), 432.

[^41]: A public good, as contrasted with a private good, is one that is not excludable, people cannot be excluded from consuming it, and nonrival, one person's consumption does not reduce the amount available to other consumers. Varian (1992), 414.
false and misleading advertising; Environmental Protection Agency policies to control air, water, and land pollution; and National Highway Traffic Safety Administration policies to promote automobile safety through precrash, crash, and postcrash standards (Greer 1987).

In recent years, state public utility commissions have become increasingly active in quality-of-service regulation. According to a recent National Regulatory Research Institute publication, “[survey] results indicate that twenty six states have undertaken service quality revisions since July 1995 . . . a tremendous amount of activity and shows just how important a new look at service quality issues is in a changing regulatory environment.”

Table 2.2 illustrates the trend in state public utility commission quality-of-service regulation for the period 1990 to 1998. The results (i.e., more state public utility commissions adopting quality-of-service standards) are consistent with the notion that quality-of-service regulation is becoming increasingly important. The normative goal of quality-of-service regulation is to induce the local telephone company to provide an adequate level of quality, as determined by the state public utility commission.

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</tr>
</thead>
<tbody>
<tr>
<td>Number of states</td>
<td>35</td>
<td>36</td>
<td>37</td>
<td>37</td>
<td>39</td>
<td>40</td>
<td>41</td>
<td>41</td>
<td>41</td>
</tr>
</tbody>
</table>

Table 2.2: State public utility commissions with quality-of-service (QOS) standards for local telephone companies for the period 1990 to 1998.

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State public utility commission quality-of-service policies often consist of redundancy requirements and measures and standards of quality. First, most state public utility commissions require local telephone companies to maintain redundant systems. Thus, for example, should a power outage occur, the local telephone company has a backup power supply to ensure continual telephone service. Second, many state public utility commissions identify aspects of local telephone service (measures) that are important for quality-of-service and establish standards for those measures. Some common measures that state public utility commissions establish standards for include dial tone delay; installation commitments met and interval; trouble and repeat trouble reports; and answer time for repair, operator, and directory service. The specific measures chosen and standards set often vary state-by-state. To implement the measure and standard program, state public utility commissions typically require telephone companies to supply quality-of-service data on a monthly or quarterly basis. In addition, some state public utility commissions also conduct field audits to directly assess company performance.

Many state public utility commissions' quality-of-service standards consist of a series of pass-fail tests. For example, consider the local telephone quality-of-service rules for North Carolina. Table 2.3 lists the quality-of-service measures and standards for North Carolina local telephone companies. As is evident from Table 2.3, there are a series of service quality measures and standards that local telephone companies must meet. Some states, such as Virginia, have several levels for the standards (e.g., satisfactory, weak spot, and unsatisfactory) for each service quality measure (20 Virginia Code 5-400-80). Berg and Lynch (1992) suggest that a program of multiple pass-fail standards, such
as the North Carolina example, is an inefficient method to promote quality-of-service. The company is required to meet the standard for each measure, regardless of the importance of the measure for network reliability or consumer satisfaction and the accompanying costs, and the company receives no benefit for exceeding a given measure. The authors suggest that a weighted "score" for all measures should be implemented, where the more important measures for network reliability and consumer satisfaction receive a higher weight. The "score" is simply a weighted sum of the company's performance on all the individual measures. In this way, each local telephone company will deploy resources in the most efficient manner to achieve an aggregate level of quality-of-service consistent with the state public utility commission's mandate.

43 Noam (1991) recommends a similar approach.
<table>
<thead>
<tr>
<th>Quality-of-Service Measure</th>
<th>Standard</th>
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</thead>
<tbody>
<tr>
<td>Intraoffice completion rate</td>
<td>99% or more</td>
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<tr>
<td>Interoffice completion rate</td>
<td>98% or more</td>
</tr>
<tr>
<td>Direct distance dialing completion rate</td>
<td>95% or more</td>
</tr>
<tr>
<td>EAS transmission loss</td>
<td>95% or more between 2 and 10db</td>
</tr>
<tr>
<td>Intrastate toll transmission loss</td>
<td>95% or more between 3 and 12db</td>
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<tr>
<td>EAS trunk noise</td>
<td>95% or more 30 dbmrc or less</td>
</tr>
<tr>
<td>Intrastate toll trunk noise</td>
<td>95% or more 33 dbmrc or less</td>
</tr>
<tr>
<td>Operator “0” answertime</td>
<td>90% or more within 10 seconds</td>
</tr>
<tr>
<td>Directory assistance answertime</td>
<td>85% or more within 10 seconds</td>
</tr>
<tr>
<td>Public paystations found out-of-order</td>
<td>10% maximum</td>
</tr>
<tr>
<td>Business office answertime</td>
<td>90% or more within 20 seconds</td>
</tr>
<tr>
<td>Repair service answertime</td>
<td>90% or more within 20 seconds</td>
</tr>
<tr>
<td>Initial customer trouble reports</td>
<td>4.75 or less per 100 access lines</td>
</tr>
<tr>
<td>Repeat trouble reports</td>
<td>1.0 report or less per 100 access</td>
</tr>
<tr>
<td>Out-of-service troubles cleared within 24 hours</td>
<td>95% or more</td>
</tr>
<tr>
<td>Regular service orders completed within 5 working days</td>
<td>90% or more</td>
</tr>
<tr>
<td>New service installation appointments not met for company reasons</td>
<td>5% or less</td>
</tr>
<tr>
<td>New service held orders not completed within 30 days</td>
<td>0.1% or less of total access lines</td>
</tr>
<tr>
<td>Regrade application held orders not completed within 30 days</td>
<td>1.0% or less of total access lines</td>
</tr>
</tbody>
</table>


Table 2.3: North Carolina service measures and standards for local telephone companies.
2.3. Theories of Regulation

Four principal theories attempt to explain the origin of and rationale for regulation and the behavior of regulators. These four theories can be grouped into two broad categories of political science and economic thought: the institutional paradigm and the public choice paradigm. The public interest and equity-stability theories fall within the institutional paradigm. The capture and interest group theories of regulation fall within the public choice paradigm. While each theory can explain certain aspects of state public utility commission regulation, none alone appears to adequately explain the broad panoply of regulatory action.

2.3.1. Institutional-Based Theories of Regulation

In the institutional paradigm, legislators and regulators promote social welfare. The foundations for the institutional paradigm are the political science and economics disciplines. To begin, there is an assumption that external influences mold the purposes and actions of individuals. These external influences are institutions. According to Hodgson (1998), institutions are complexes of habits, roles, and conventional behavior. Institutions, whether a social or economic organization or a personal habit, are assumed to influence individuals’ behavior. Thus, in this paradigm, there is an assumption that individuals may behave in a non-deliberative or unconscious manner. This is contrary to the rational, individualistic behavior assumed in the public choice paradigm. The
institutional paradigm has important implications for the theories of regulation. If institutions influence individuals' behavior, legislators and regulators will be influenced by forces in addition to their individual self-interests. Specifically, social institutions, mores, and habits might influence legislators and regulators to behave in a benevolent manner that promotes social welfare.

The public interest theory of regulation is the most prominent institutional-based theory. According to Phillips (1993), the public interest theory of regulation “holds that regulation is undertaken to protect the consumer from the abuses of market imperfections.” This definition has implications for both the origin of regulatory agencies and the behavior of regulators. Regulation and regulatory agencies are a response to (1) the concentration of economic power, (2) the impersonalization of economic relationships, and (3) the complex and interdependent socioeconomic structures (Reagan, 1987). In the public interest theory, these institutional forces induce market imperfections that can harm segments of the population. The segments of the population harmed by market imperfections will engage in political action to secure government protection. According to Reagan, the Interstate Commerce Commission, the Federal Trade Commission, and state public utility commissions were all a response to these conditions. Once regulatory agencies are established, the public interest theory of regulation assumes that regulators will undertake policies that mitigate the market


45 In Kingdon’s (1995) model, political action can be expected when a problem, policy, and politics align. This implies that regulatory agencies should arise when market imperfections (a problem) cause political strife (politics) and regulation (policy) is an acceptable proposal.
imperfections responsible for the agency's formation. These policies will foster greater economic efficiency and equity. Thus, regulators are pragmatic problem solvers who are influenced by institutional forces to improve social welfare and equity.

The public interest theory is principally normative. Namely, the public interest theory explains what "should be." Regulation should be a response to market imperfections that seeks to improve economic efficiency and equity. However, some research also provides support for positive aspects of the public interest theory. The public interest theory can also explain "what is." One example concerns the explanation for the deregulation in the telecommunications industry. Teske (1991) found that institutional factors, including the resources of state public utility commissions, ideology, and legislative party control, influence state public utility commission policy decisions more than interest groups. Zearfoss (1997) found that the resources and structural characteristics of state public utility commissions, both institutional factors, influence the commissions' ability to protect captive ratepayers. Thus, while the public interest theory of regulation is principally normative, some research also supports it as a positive theory.

The public interest theory of regulation is not without critics. Criticisms of the public interest theory concern the assumptions and the lack of empirical support for its hypotheses. According to Posner (1974), the theory is based on two underlying assumptions: (1) economic markets are extremely fragile and likely to operate inefficiently and (2) government regulation is virtually costless. However, many neoclassical economists believe that economic markets are very robust and, as Phillips (1993) notes, government regulation is not costless, either in terms of money or resource misallocation.
Further, neoclassical economists suggest that the notion that legislators and regulators behave in a benevolent manner, rather than in a self-interested manner in response to interest group pressures, is naive. Regarding the empirical evidence, Posner notes that “some fifteen years of theoretical and empirical research . . . demonstrated that regulation . . . cannot be explained on the ground that [it] increases the wealth or, by any widely accepted standard of equity or fairness, the justice of the society.”  

The public interest theory of regulation has important implications for understanding state public utility commission regulation of the local telephone industry and quality-of-service. In the public interest theory, there is the assumption that state public utility commissions were organized to mitigate market imperfections and that regulators will develop policies that promote economic efficiency and equity. As mentioned in section 2.1, the local telephone industry has been dominated by local monopolies. Monopolies pose both efficiency and equity problems. Most well known, monopolies will reduce quantity supplied and raise price. Further, as explained in chapter 4, monopolists will distort quality with both efficiency and equity ramifications. Thus, under the public interest theory of regulation, state public utility commissions will adopt policies mitigating the pricing and quality problems of local telephone monopolies to promote both economic efficiency and equity.

\footnote{Posner (1974): 336-337.}

\footnote{Examples of the empirical literature that present conclusions counter to the public interest theory of regulation are discussed below in section 2.3.2.}

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Among the four theories that attempt to explain the origin of and rationale for regulation and the behavior of regulators, the equity-stability theory receives the least amount of attention in the literature. In the equity-stability theory, regulation is a response to the unimpeded operation of markets (Trebing 1981). The markets are not necessarily inefficient. Rather, legislators and regulators attempt to protect consumers. The overriding goal is the promotion of fairness, social values, and stability. To accomplish equity and stability, markets are replaced with administrative-judicial institutions, such as state public utility commissions. The equity-stability theory is clearly an institutional-based theory of regulation. Regulatory agencies are established to promote the social goals of equity and regulators are assumed to behave in a manner that furthers those goals. Interest groups and self-serving motives are absent from the equity-stability theory. However, unlike the public interest theory of regulation, the other institutional-based theory, the equity-stability theory has no place for economic efficiency. The sole rationale for regulation and the motivation for regulators is equity. Phillips (1993) offers two criticisms of the equity-stability theory. First, the theory does not explain the deregulation in the telecommunications industry. The trend towards deregulation represents a movement towards a greater reliance on market forces, rather than a reliance on administrative-judicial institutions. Second, the theory provides no guidance to regulators concerning the judgmental nature of equity.

The equity-stability theory of regulation also has implications for understanding state public utility commission regulation of the local telephone industry. Regulators’ behavior will be driven by a desire to promote equity and stability. Regulators can be
expected to reduce monopoly local telephone rates, not for economic efficiency reasons, but rather to increase consumer surplus and reduce monopoly profits (i.e., equity reasons). Further, the theory can explain the presence of quality-of-service programs. These programs promote equity by ensuring that all consumers receive adequate local telephone service.

2.3.2. Public Choice-Based Theories of Regulation

Public choice is “the economic study of nonmarket decision making, or simply the application of economics to political science.”48 Downs (1957) offers perhaps the earliest public choice analysis. Downs examines the micro-level behavior of politicians and voters. There are four assumption in Down’s analysis: (1) voters behave rationally to maximize utility, (2) politicians behave rationally to maximize political support, (3) there is uncertainty, and (4) the winning politician controls government policy. The combined impact of these assumptions means that voters will remain inactive on many issues. Inactivity is influence by the costs of becoming informed and active. Voters will only become active when the cost of becoming informed are low, issues that Downs refers to as production specialization, or the influence of a policy change will significantly influence the voter’s utility. Therefore, voters will remain inactive on most distributive policy issues where the costs of the policy are widely disbursed and the benefits are concentrated (Lowi

These public choice concepts have direct implication for state public utility commission regulation. The public choice literature argues that a policy with concentrated benefits and disbursed costs (e.g., a local telephone rate increase)\textsuperscript{49} will most likely be implemented by regulators regardless of the economic efficiency or equity ramifications. Alternatively, a policy with concentrated costs and disbursed benefits (e.g., local telephone quality-of-service standards)\textsuperscript{50} will most likely not be implemented by regulators.

The capture theory suggests that, while regulatory agencies are initially created to protect consumers, they come to be dominated by the regulated industries (Phillips 1993 and Posner 1974). The pattern of a regulatory agency becoming dominated by the regulated industries is consistent with public choice theory. The regulated industries are active in the policy process because their costs of becoming informed are low and the benefits are concentrated. At the same time, the general public is not active because their costs of becoming active are high and the benefits are disbursed. Phillips (1993) discusses the life cycle approach to explain the capture theory. In the life cycle approach, there are four periods: (1) gestation, (2) youth, (3) maturity, and (4) old age. The major activity in the gestation period is the origin of the regulatory agency. The agency arises from a publicly recognized problem. In the youth period, the regulatory agency vigorously pursues its mandate to resolve the public problem. These first two periods are consistent

\textsuperscript{49} A local telephone rate increase provides concentrated benefits to the local telephone company in the form of greater revenues and disbursed costs to all consumers in the form of higher rates.

\textsuperscript{50} Local telephone quality-of-service standards provide disbursed benefits to all consumers in the form of improved service and concentrated costs to the local telephone company in the form of higher operating costs. As an alternative perspective, chapter 3 discusses the operations research-based paradigm which assumes that improved quality does not increase operating costs.
with the public interest and equity-stability theories. The regulatory agency pursues policies to improve economic efficiency or equity, or both. Capture begins to occur in the maturity period, when the regulatory agency becomes identified with the regulated industries. The regulatory agency dedicates increasing attention to protecting the health of the regulated industry versus promoting economic efficiency and equity. In the old age period, the agency loses most public support and becomes closely aligned with the regulated industry. According to Phillips (1993), the Interstate Commerce Commission is a classic example of the capture theory in action.\footnote{The Interstate Commerce Commission was eliminated in 1995.}

There are several weaknesses with the capture theory (Posner 1974). First, the theory cannot address situations where the regulatory agency has authority over industries with conflicting interests. For example, FCC regulates both telephone and cable television companies. Yet, the interests of the telephone and cable television industries are often conflicting. Therefore, the theory cannot explain which industry will "capture" the commission. Second, the theory ignores the possibility that consumer groups might dominate the regulatory agency. For example, the theory cannot explain the presence of universal service programs that benefit consumers while imposing costs on regulated industries. Third, the theory assumes that the regulatory agencies are created to pursue the public interest. As the interest group theory suggests, some agencies are not created to improve economic efficiency or equity. Finally, the theory does not allow for agency renewal through new appointments and new authority and procedures. With the
appointment of new commissioners, and especially a chairperson, or a new legislative mandate, the direction of a regulatory agency can change and thus mitigate the agency capture.

The capture theory can provide insights on certain aspects of state public utility commission actions. The theory suggests the commissions will aggressively implement policies that promote economic efficiency and equity in the years immediately following the commission’s founding. These policies would focus on lowering utility rates and improving quality-of-service. However, as the commission becomes entrenched, policies that hinder the firms’ profitability (e.g., stringent quality-of-service standards) should be expected to be removed or at least softened.

The interest group theory\textsuperscript{52} explains the origin of regulation and the behavior of regulators through the action of political coalitions (Phillips 1993). Stigler (1971) is the seminal article in the interest group theory literature. Stigler adopts a market-oriented approach to explain the origin of regulation and the behavior of regulators. According to Stigler, the government possesses a valuable resource that can be sold. That resource is the power to coerce. The power to coerce is valuable to businesses because it can be used to (1) provide a direct subsidy of money, (2) control entry of new rivals, (3) influence substitute and complementary products in a beneficial manner, and (4) promote price fixing. Since the power to coerce is a scarce and valuable resource, Stigler asserts that neoclassical demand analysis can be applied to explain its use. In the theory, the supply of

\textsuperscript{52} The interest group theory of regulation is also referred to as the economic theory of regulation.
regulation by government is driven by political coalitions. Businesses are assumed to supply resources and votes to legislators and regulators. Because opposition is diffuse, it is not in the interest of the legislator or regulator to oppose the business demands for regulation. Thus, Stigler concludes that "regulation is acquired by the industry and is designed and operated primarily for its benefit."53

Later literature generalized the narrow scope of the interest group theory as developed by Stigler. The modified theory explains regulation and regulators' behavior as the response to the demand of interest groups struggling among themselves (Posner 1974). Foremost in this literature is Peltzman (1976). According to Peltzman, decision makers must balance the support among competing interest groups based on their intensity of preference and collective action power. To explain the theory, Peltzman develops a model with two competing interest groups (businesses and consumers) and one vote maximizing regulatory agency. The regulator will choose a course of action that maximizes its votes, where both interest groups can influence the regulator's decision. As a result, the regulator balances the interests of the competing interest groups. However, the regulator's actions will generally favor businesses because they will be more organized (Olsen 1965) and have a greater intensity for regulatory action. But, the regulator will not completely ignore consumer interests.

There is much empirical literature testing the hypotheses of the interest group theory of regulation. Stigler and Friedland (1962) examine the impact of state public utility commission regulation on the electric industry. Using descriptive statistics and multiple regression analysis, the authors find that regulation has no significant impact on the electric industry, contrary to the public interest theory of regulation.\textsuperscript{54} There are several empirical articles that examine the interest group theory of regulation in the telecommunications context. Kaserman, Mayo, and Flynn (1990) examine the factors that influence a state public utility commission's decision on universal service funding. The authors find that the presence of intense toll use by business (i.e., a concentrated interest that would oppose universal service funding) is associated with lower universal service funding. Donald and Sappington (1995 and 1997) examine the factors that influence a state public utility commission's decision on alternative regulation plans versus rate-of-return regulation. The authors find that strong firm support is associated with passage of alternative regulation plans. In addition, if consumers stand to lose from the alternative regulation plan, passage is less likely. This result provides support both to the interest group theory as espoused by Peltzman, because the regulator is balancing business and consumer interests, and also the public interest theory, because the regulator is considering economic efficiency and equity concerns.

\textsuperscript{54} Although, if the interest group theory of regulation were to hold, electric rates should have been higher under regulation.
While the empirical literature provides some support for the interest group theory of regulation, there are weaknesses with the theory. First, the theory simplifies the government and regulatory process (Breyer 1982). Most state public utility commissioners are appointed, not elected. Therefore, the assumption that regulators are vote maximizers is not an entirely accurate representation of the regulatory environment. In a related institutional concern, the theory ignores the internal organizational structure of state public utility commissions (e.g., independence of staff, financial resources) that influences regulatory action. As Zearfoss (1997) shows, the internal structure of state public utility commissions can influence commissioner decisions. State public utility commission decisions are also subject to judicial review. These examples illustrate how the interest group theory overly simplifies the government and regulatory process.

Second, the interest group theory is not well suited to explain the trend towards deregulation. As Derthick and Quirk (1985) note, “the regulated industries in our three cases [airline, shipping, and telephone] did not ask to be deregulated.”55 While the interest group theory of regulation provides a plausible explanation for the origin of regulation, it does not explain why state public utility commissions and federal regulators would institute deregulation. Third, the interest group theory does not adequately explain the presence of internal subsidies (e.g., universal service). Posner (1971) suggests that public finance theory (e.g., a distributive tax policy) better explains the large scale internal

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subsidies present in regulated industries such as telecommunications. Thus, many weaknesses are present in the interest group theory of regulation, just as with the other theories.

The interest group theory provides guidance on certain aspects of state public utility commission actions. Commissions can be expected to undertake actions that principally benefit the regulated industries. This would imply limiting competitive entry, approving rate increases, and providing minimal oversight of quality-of-service. However, some attention will be paid to issues that are a concern to consumers and thus could explain a minimum amount of quality-of-service regulation. In this respect, the commission is balancing regulated industry and consumer interests, with a greater emphasis on the regulated industry interests.

2.3.3. Theories of Regulation and State Public Utility Commissions

While each theory of regulation provides insights on specific aspects of state public utility commission behavior, none alone appears to adequately explain the full range of regulatory action. The public interest theory provides an explanation for commissions adopting policies that regulated industries oppose (e.g., stringent quality-of-service standards). The institutional forces induce commissioners and staff to adopt policies that promote efficiency and equity. The equity-stability theory also can explain stringent quality-of-service standards as a commission mechanism to promote equity. The capture theory can explain certain elements in the lifecycle of commissions. For example,
commissions were generally very proactive immediately following their origin. Finally, the interest group theory helps explain how commissions balance the interests of regulated industries and consumers. This would explain the presence of actions that regulated industries favor (e.g., rate increases) and actions that consumers favor (e.g., quality-of-service standards).

However, the environment in which state public utility commissions operate seems to indicate that elements of all theories are present. Many commissions originated in response to political demands during the progressive era (Reagan 1987). The political demands arose from the perceived problems arising from increasing market power in many public utility industries. Yet, there does appear to also be a weighting of regulated industry and consumer interests. While theory suggests the weighting will favor the regulated industries, the empirical literature addressing state public utility commissions is somewhat mixed.
CHAPTER 3

THE NATURE OF QUALITY AND ITS APPLICATION TO THE TELEPHONE INDUSTRY

In this chapter, I examine several paradigms that address the nature and definition of quality as well as the application of quality to the telephone industry. Three major paradigms provide insights on quality: the economics-based, marketing-based, and operations research-based paradigms. Each paradigm has a different definition of quality and emphasizes different dimensions of quality. While each paradigm provides important insights on quality, none appears complete on its own. In the telephone industry, quality can be related to the telephone network or to functions and services that support and augment the services provided over the telephone network. Within the literature on telephone-industry quality, there is an increasing emphasis on evaluating both the telephone network and the supporting and augmenting functions and services. Finally, I propose a framework for examining quality-of-service in the local telephone industry that both incorporates concepts from the three paradigms and takes into account the different incentives for local telephone companies to provide equipment and system oriented service quality versus people and process oriented service quality.
3.1. Paradigms and Dimensions of Quality

Garvin (1984 and 1988) identifies three major paradigms that systematically explain quality.\textsuperscript{56} These are the economics-based, marketing-based, and operations research-based paradigms.\textsuperscript{57} In the economics-based paradigm, differences in quality reflect differences in the quantity of some attribute or characteristic. Because quality can be quantified, quality is an objective, measurable, and timeless variable. In the marketing-based paradigm, quality concerns whether the good or service satisfies the consumer's wants and needs. This implies that quality "lies in the eyes of the beholder" and is therefore subjective and socially determined. In the operations research-based paradigm, quality is associated with conformance to standards or requirements. The presence of several paradigms that explain quality has two important implications. First, there is no consensus on the definition of quality. Second, each paradigm emphasizes different dimensions of quality. Because of these two implications, company-to-company, company-to-regulator, and regulator-to-regulator relations might be complicated. For example, a company with a marketing-based approach to quality might conflict with a regulator with an operations research-based approach to quality. The company's goal is

\textsuperscript{56} Garvin also identifies the transcendent and value-based approaches. In the transcendent, or philosophy-based, approach, quality cannot be defined precisely but is synonymous with "innate excellence" (i.e., the individual knows quality when they see it). In the value-based approach, a quality good is one that provides performance at an acceptable price. These two approaches receive less attention in the literature than the remaining three approaches discussed more fully in the chapter.

\textsuperscript{57} Garvin refers to these as the product-based, user-based, and manufacturing-based approaches to defining quality, respectively. The categories economics-based, marketing-based, and operations research-based paradigms are used because Garvin's approaches most closely align with these three academic disciplines or paradigms.
to satisfy the consumers' quality demands, regardless of whether the service meets various
technical standards. However, the technical standards will be paramount for the regulator.
The result might be disagreements regarding the service provided by the company, with
implications for penalties and licensing. Similar problems could arise in private
contracting between companies or congruence between regulators in two different
jurisdictions.

3.1.1. Economics-Based Paradigm

In the economics-based paradigm, the concept of a good or commodity is an
appropriate place to begin. Tirole (1988) defines a good or commodity as a bundle of
characteristics including the location, time, availability, and quality. Consumers will have
rankings over the various characteristics and these rankings will influence demand for the
good or commodity. As soon as one of the various characteristics changes, a different
good or commodity results (Debreu 1954). For example, with this definition, telephone
service that can move with an individual (e.g., cellular service) is a different good or
commodity than telephone service that is fixed in a particular location (e.g., wireline
service). Tirole identifies three types of goods or commodities related to quality. A
search good is one where the quality can be ascertained prior to purchase. Clothing is a
common example of a search good because the consumer can examine the quality of the
fabric and workmanship prior to purchase. An experience good is one where the quality
can be ascertained only after the purchase. Telephone service is an example of an
experience good. The consumer cannot determine the level of quality prior to ordering or using the service. With an experience good, information is critical to the consumer’s purchase decision. Since the consumer cannot ascertain the level of quality until after the purchase, reputation, signaling of quality, and the possibility of repeat purchases become important information transmittal mechanisms. Finally, a credence good is one where quality is rarely learned. For example, a consumer can rarely learn the quality of the fluoride in toothpaste even after purchase.

The economics-based paradigm has a product focus to quality. Differences in quality reflect a difference in the quantity of some attribute or characteristic associated with the product. Because quality can be quantified, this implies that quality is an objective, measurable, and timeless variable (Garvin 1984 and 1988). For example, durability or reliability is an attribute of quality in the economics-based paradigm. A good that operates for a longer period of time (i.e., a more durable or reliable good) and therefore provides a greater quantity of service will be considered a higher quality good in the economics-based paradigm than a good with less durability or reliability. Durability or reliability is an objective, measurable, and timeless indicator of quality because the length of service can be easily quantified. Additionally, in the economics-based paradigm quality is a form of vertical differentiation (Tirole 1988). Individuals will agree on the ranking of the goods or services, because quality is objective and measurable. However, individuals will have different valuations of the goods or service. Again, considering the durability example, individuals will agree on the rankings of the good based on the durability (i.e., the more durable, longer lasting good has higher quality). But, consumers will have
different willingness to pay for the durability. Garvin identifies two correlates associated with the economics-based paradigm. First, higher quality can only be obtained at a higher cost. The positive correlation between quality and cost occurs because a higher quality good or service contains a greater quantity of some attribute or characteristic that requires costly resources. The company will only improve quality if demand increases sufficiently that incremental revenues exceed the incremental costs. Second, quality is an inherent characteristic of goods and services rather than something ascribed to them by consumers and society. Since quality is quantifiable, social trends will not influence the quality measure.

Lancaster (1966) developed an approach, referred to as the goods characteristics approach, that was the forerunner to many concepts in the economics-based paradigm. In Lancaster’s approach, goods consist of a set of properties or characteristics. The good is the input and the properties or characteristics are the output. Consumers derive utility from the properties or characteristics. Consumers agree on the properties or characteristics (i.e., the properties or characteristics are objective). However, consumers can have different preferences or willingness to pay for the properties or characteristics (i.e., vertical differentiation is present). In this approach, the consumer receives no utility from the good per se. Thus, consumers rank goods based on the properties or characteristics and demand for the good is derived indirectly through these properties or characteristics. A light bulb is a common example in Lancaster’s goods characteristics approach. The good, a light bulb, is the input and the amount of hours of light is the output or relevant characteristic. Consumers derive utility from the hours of light, not the
light bulb itself. Consumers agree that the amount of hours of light is the characteristic and that more hours of light is preferable to less. However, consumers can have different willingness to pay for different hours of light from a light bulb.

Three major implications arise from the economics-based paradigm. First, since quality is associated with the quantity of an attribute or characteristic, the company and regulator will focus solely on the product. Consumers’ preferences will not be a primary concern. Thus, while consumers may rank the goods or services consistently on the objective measure, consumers’ demand for the goods or services may decline because the goods or services no longer meet their wants or needs. Second, since quality is objective, measurable, and timeless, establishing standards is relatively easy. An objective measure is simpler to establish standards for and gauge performance than a subjective measure. Additionally, consumers share options regarding the rankings of quality and rankings will remain relatively constant. Also, standards will not have to change with changing social trends. Third, regulators should expect resistance from companies in establishing standards. This resistance occurs because improved quality imposes higher costs. Unless the company can recover the additional costs, the company will oppose standards because they will reduce profits.
3.1.2. Marketing-Based Paradigm

In the marketing-based paradigm, consumers’ perceptions determine what constitutes quality. According to Garvin (1984 and 1988), quality “lies in the eyes of the beholder” or consumer. Since there is no objective measure, quality is subjective. In the marketing-based paradigm, measurable attributes or characteristics and conformance to company or regulator standards or requirements are not important. In general, the good or service that best satisfies a given consumer’s wants or needs, in that consumer’s eyes, is the good or service with the highest quality. This implies that quality is directly related to consumer satisfaction.58 Because consumers are heterogeneous, consumers have different wants and needs and therefore different perceptions regarding quality. Also, because consumers perceptions of their wants and needs can change over time, often in response to marketing or social trends, what consumers consider to be quality will also change over time (Takeuchi and Quelch 1983). Thus, quality is also socially determined. There is not a timeless measure of quality. For example, using the marketing-based paradigm, what constitutes quality in the automobile industry has shifted from large automobiles to smaller, fuel efficient automobiles and perhaps back to larger automobiles. The marketing-based paradigm is decidedly externally focused.

58 Garvin (1988) provides an interesting example of one implication arising from the marketing-based paradigm’s focus on consumer satisfaction. A book on The New York Times best seller list most likely provides greater consumer satisfaction than a literary classic. However, does this imply that the books on The New York Times best seller list are “better” than the literary classics? In the marketing-based paradigm, “better” as defined by literary experts and academics is not relevant.
Two models will illustrate the marketing-based paradigm in more detail. The first model is the Zeithaml, Parasuraman, and Berry (1990) model. The authors define quality as the amount of discrepancy between the consumer’s expectations and the consumer’s perceptions. There are four factors that influence the consumer’s expectations about a good or service. These factors are word-of-mouth communications (e.g., recommendations from family, friends), the consumer’s personal needs, the consumer’s past experiences, and external communications from the company (e.g., advertising). The consumer’s perceptions are the result of the consumer’s evaluation of the good or service based on five dimensions.\textsuperscript{59} The five dimensions are tangibles (i.e., the physical appearance), reliability, responsiveness, assurance (i.e., knowledge and courtesy of employees), and empathy (i.e., caring and individualize attention). The perceived service quality is the difference between the expected service and the perceived service. If expected service exceeds perceived service, the consumer will view the quality as poor. However, if perceived service exceeds expected service, the consumer will view quality as good. In both instances, the evaluation is the subjective judgment of the consumer and could change over time. The second model is the Hardie and Walsh (1994) model. The authors define quality as the difference between preferred performance and actual performance. The authors identify five key states in a complete transaction between a company and a consumer. These states are the consumer’s actual need, the company’s perception of the consumer’s need, the company’s expected performance, the company’s

\textsuperscript{59} The dimensions of quality are discussed more fully below in section 3.1.4.
actual performance, and the consumer’s perception of the performance. In this model, quality is better when the gaps between the five states are minimized. For example, quality is better if there is little difference between the consumer’s actual need and the company’s perception of the consumer’s needs. If this gap is minimized, the company is more likely to meet the consumer’s actual need which increases the consumer’s perception of quality. Again, quality is subjective and could change over time in this model.

Several important implications arise from the marketing-based paradigm. First, the quality of a good or service will differ from consumer-to-consumer because of differences in expectations and perceptions. What is considered good quality to one consumer might be considered poor quality to another consumer. This is clearly different than the economics-based paradigm where consumers agree on the ranking of goods and services. For regulation, this implies that establishing standards will be difficult because there could be no consensus regarding what constitutes quality. Quality is by nature subjective.

Second, what consumers desire among the various dimensions of quality can change over time because quality is socially determined. While a sturdy and indestructible rotary phone was considered good quality in the past, today quality in telephones is associated with features and functions and less with indestructibility. For regulation, this subjectivity implies that standards must change over time. Finally, in a service industry, quality consists of both a process and results component (Harvey 1998). Even if the result satisfies the consumer’s actual need, quality could be considered poor if the perceived process deviated in a negative manner from the expected process.
3.1.3. Operations Research-Based Paradigm

Quality is associated with conformance to standards or requirements in the operations research-based paradigm. To accomplish a comparison with standards or requirements, quality must be objective and timeless in the operations research-based paradigm. According to Garvin (1984 and 1988), any deviation from standards or requirements implies a reduction in the quality of a good or service. Harvey (1998) defines quality as the extent to which the good or service is consistent with the state-of-the-art in the field. These two operations research-based definitions of quality imply an internal focus. In the design of a good or service, a reliability engineering focus is present to identify possible problems and design alternatives with fewer possible problems. Also, in the manufacturing or delivery of a good or service, a statistical quality control focus is present to discover when problems occur (Garvin 1984 and 1988). A quality assurance program, which consists of reliability engineering and statistical quality control, should ensure that quality is designed and built into goods and services (Collins 1994). This internal focus is contrary to the marketing-based paradigm. Quality is only indirectly associated with consumer satisfaction. A good or service that does not conform to standards or requirements is less likely to meet consumers’ wants and needs and therefore lead to less consumer satisfaction. However, consumer satisfaction is not the direct focus. Because of the focus on conformance to standards or requirements, quality is associated with lower costs. A good or service that meets the relevant standards or requirements will
have fewer defects. Since defects require costly repair or rework, improved quality can lower costs. This is contrary to the economics-based paradigm where improved quality is associated with higher costs.

Three implications arise from the operations research-based paradigm of quality. First, because of the internal focus, the company might lose consumers to competitors who better meet the consumers’ wants and needs. This is especially important if tastes and preferences change over time. Thus, the company could be producing a good or service with low cost that meets all standards or requirements but that few consumers desire. Second, regulators can establish objective standards. There is not a concern about competing perceptions of quality. Further, the standards will not need continual refinement due to changing consumer perceptions and social preferences as in the marketing-based paradigm. However, standards will need to be changed to reflect advancements in technology. Third, an enlightened and profit maximizing company should share the regulator's goal of establishing objective standards. Since improved quality will lower costs, the company should encourage standards that promote improved quality, especially if the regulator incurs some of the cost in developing the standards and monitoring performance.
3.1.4. Dimensions of Quality

Because of the multiple paradigms and definitions, several authors have introduced the notion of dimensions as another approach to thinking about quality. Dimensions are basic elements of quality or criteria that consumers use to judge the quality of a good or service. Since many dimensions can apply for a given good or service, this approach implies that quality has multiple dimensions. The dimensions approach is compatible with the three paradigms discussed previously. Each paradigm simply emphasizes a different set of dimensions.

Three authors develop generalized dimensions of quality. Garvin (1987) identifies eight dimensions of quality applicable to goods. These dimensions are performance (i.e., primary product characteristics), features (i.e., secondary product characteristics), reliability, conformance to standards or requirements, durability, serviceability (i.e., speed, courtesy, and competence of repairs), aesthetics, and perceived quality. Brucks, Zeithaml, and Naylor (2000) identify six dimensions of quality applicable to goods. These dimensions are ease of use, versatility, durability, serviceability, performance, and prestige. The authors indicate that versatility is consistent with Garvin’s features dimension and that prestige is consistent with Garvin’s aesthetics and perceived quality dimensions. Finally, Zeithaml, Parasuraman, and Berry (1990) identify five dimensions of quality applicable to services. These dimensions are tangibles (i.e.,

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60 The dimensions of quality applicable specifically to the telephone industry are discussed below. In addition, other authors have developed dimensions for many other industries, including health care and education.
appearance of facilities and personnel), reliability, responsiveness (i.e., willingness to help the consumer), assurance (i.e., knowledge and courtesy of personnel), and empathy (i.e., caring and individualized attention).

The dimensions approach to quality has both advantages and disadvantages. By emphasizing dimensions of quality, the authors are able to discuss quality without the constraints imposed by a specific definition. This implies that quality can be perceived more broadly, in a multi-dimensional perspective. Thus, a richer notion of quality is developed. However, there remains an uncertainty about quality. A list a dimensions is not a theory; a theory requires a generalization based on the list of dimensions (Silberberg 1990, 1). While the notion of quality is rich, it is not very useful in analysis. Further, there is no guarantee that consistency between companies and regulators will exist when companies and regulators consider dimensions of quality.

3.2. Quality in the Telephone Industry

In this section, I examine the nature of quality in the telephone industry. There are two distinct aspects of service in the telephone industry. The first aspect is directly related to the telephone network. The telephone network consists of the hardware and software necessary to transmit a signal from one point to another. The second aspect is related to supporting and augmenting the services directly related to the telephone network. I classify these activities as pre-service activities, service provision activities, and post-service activities. Several authors provide comprehensive reviews of quality in the
telephone industry. In general, the trend is towards an expansion of the concept of telephone quality from a traditional emphasis on the reliability of the telephone network to an evaluation of the telephone network and the supporting and augmenting functions and services. Finally, I propose a framework for examining quality-of-service in the local telephone industry that both incorporates concepts from the three paradigms that examine quality and takes into account the different incentives for local telephone companies to provide equipment and system oriented service quality versus people and process oriented service quality.

3.2.1. A Brief Introduction to the Telephone Network\textsuperscript{61}

The local loop is the basic element of the telephone network. The local loop consists of the wires extending from the telephone company's facility to the consumer's premises. For each consumer, the local loop consists of a pair of twisted copper wires.\textsuperscript{62} The local loop terminates in either a central office, discussed in more detail below, or a remote terminal.\textsuperscript{63} If the local loop terminates at a remote terminal, fiber optic cable, versus copper wire, carries the signal to the central office. The local loop is established in

\textsuperscript{61} There are many sources that discuss the telephone network in great detail. For example, see Bates and Gregory (1998).

\textsuperscript{62} In the past, "party line" service was prevalent in less densely populated areas. With "party line" service, several consumers shared a pair of twisted copper wires, or a local loop.

\textsuperscript{63} A remote terminal is a telephone company facility where the local loops for a specified service area are aggregated and transferred to fiber optic cable. The remote terminal can be either a "closet" or a buried facility typically located on the public right-of-way near the intersection of several roads.
a “star” configuration. The “star” name arises because every consumer’s pair of twisted copper wires begins at the central office or remote terminal and terminates at the consumer’s premises. Thus, all wires that form the local loop diverge from one central point, the central office or remote terminal. The pair of twisted copper wires that constitute the local loop can be strung overhead on poles, buried, or placed in conduits in urban locations. Traditionally, the transmission of signals over the pair of twisted copper wires occurred in the 300 to 3,300 hertz (htz) frequency. This 3,000 htz band of frequency is optimal for voice transmission because it includes the vast majority of the frequency that the human ear can detect. However, the capacity is limited and data signals must be converted from digital format to analog for transmission through the 300 to 3,300 htz frequency. Services introduced by telephone companies in the 1990’s are exploiting the higher frequencies available over the twisted pair of copper wires. These services include integrated services digital network (ISDN) and digital subscriber line (DSL). Because these services use the frequencies above 3,300 htz, much greater capacity is available for data or video transmission, and data or video transmission and voice transmission can occur simultaneously over the same pair of twisted copper wires.

The process of routing signals to their final location begins and ends at a central office. Wires from the local loop or remote terminals terminate at the central office. At the central office, there are a series of cross-connects. These cross-connects sends signals to the switch in the central office or a central switching facility. Switching establishes the logical connection between the consumer and the termination point. In the past, switches were analog and located in the central office serving the consumer. Digital switches,
known as digital stored program controlled (DSPC) switches, are most prevalent today. In addition, switching is increasingly moving to out-of-channel signaling. Out-of-channel signaling employs frequencies outside the 300 to 3,300 hertz range to send signaling information to the switch that establishes the logical connection for the signal transmission. Signaling system 7 (SS7) is the most prevalent out-of-channel signaling technology and uses packet switched technology. With SS7 technology, telephone companies are moving switching technology to centralized switching centers and away from individual central offices.

The final aspect of the telephone network consists of the connections between central offices and long distance companies’ points-of-presence. For the most part, local telephone companies connect their various central offices in a “ring” configuration. The “ring” consists of high capacity fiber optic cables that are referred to as interoffice trunks. Long distance companies connect to the “ring” at individual points-of-presence. When the consumer dials a long distance telephone number, the local telephone company’s switch sends the signal to the long distance company’s point-of-presence. The local telephone sends the signal to the appropriate long distance company based on the consumer’s pre-selection of a long distance company. At the point-of-presence, the long distance company assumes responsibility. The long distance company switches and transmits the signal to the terminating point-of-presence on its network. From the terminating point-of-presence, the local telephone company switches and transmits the signal through the terminating central office and to the final destination.
3.2.2. Non-Network Aspects of Telephone Service

In the past, network performance has been assumed to uniquely measure quality-of-service in the telephone industry (Ooedan, Ward, and Mullee 1997). However, telephone companies perform many functions and provide many services beyond constructing a physical network. Thus, it is important to incorporate these functions and services that support and augment the network performance into the evaluation of local telephone quality-of-service. Ooedan, Ward, and Mullee refer to these functions and services as surrounding service quality, or service surround. I classify these functions and services into three categories: (1) pre-service activities, (2) service provision activities, and (3) post-service activities.

The pre-service activities include functions and services provided by the local telephone company prior to the consumer using the network. I identify three categories of these pre-service activities. First, pre-service activities include functions and services that provide a mechanism for the consumer to receive telephone service. Promotion and education materials are necessary for consumers to learn about the company's services.\(^{64}\) The company must also maintain a trained and sufficient number of staff to answer consumers' questions, provide consumers with information to make informed service choices, and process orders correctly. Second, pre-service activities include functions and services that provide a mechanism for the timely installation of service. This can include

\(^{64}\) For example, a person moving to an area needs information regarding the company, or companies, that provide local telephone service.
developing and maintain computer systems to quickly assign telephone numbers or extending the local loop to the consumer's premises. Again, this involves maintaining a trained and sufficient number of staff. Third, pre-service activities include functions and services that provide mechanisms for consumers to change their service. Similar to the initiation of new service, the local telephone company must provide sufficient promotion and education materials as well as a trained and sufficient number of staff for consumers to make informed choices and for the change requests to be executed quickly and accurately.

The service provision activities include functions and services provided by the local telephone company that support activities over the network. I identify two categories of service provision activities. First, service provision activities include the functions and services that help consumers efficiently and effectively use the network. These functions and services include operator services, directory assistance, and technical assistance (e.g., assistance on voice mail services, installation and use of a computer modem). These activities require a trained and sufficient number of staff to be performed in a high quality manner. Second, service provision activities include functions and services that keep the network operating. These activities include repair and maintenance. Again, these activities require a trained and sufficient number of staff. Also, the local telephone company must have in place processes to prevent network failures and to allocate staff resources efficiently and effectively in case of network failures.

The post-service activities include functions and services provided by the local telephone company after the consumer has used the network. These activities include functions and services related to consumer account maintenance. These activities include
(1) providing informative, complete, and accurate billing; (2) preventing unauthorized changes to or charges to consumers’ accounts; and (3) maintaining safeguards over consumers’ account information. Again, the company must maintain a trained and sufficient number of staff to perform these activities in a high quality manner. Additionally, the company must have in place processes and procedures to efficiently and effectively perform the activities and to establish parameters for company decision making regarding the use of proprietary consumer information.

3.2.3. Literature Addressing Quality in the Telephone Industry

In the introduction to a volume devoted to the quality and reliability of the telecommunications infrastructure, Lehr (1995) addresses the changing perspective on quality in the telecommunications industry. Traditionally, quality of service in the telephone industry consisted of company performance on a relatively small set of measures associated with the telephone network. According to Lehr, this is a very narrow definition of quality. This traditional definition of quality is consistent with the operations research-based paradigm discussed earlier. Namely, quality consisted of conformance to network standards, with an internal and network focus. However, Lehr believes that a more appropriate definition of quality is any non-price product or network feature that either enhances consumers’ perceived value or lowers cost. This definition consists of a marketing-based and operations research-based component. By focusing on features that enhance consumers’ perceived value, the definition is marketing-based because it
considers the issues that consumers perceive are important. At the same time, by focusing on lowering cost, the definition is operations research-based because conformance to standards results in lower costs according to that paradigm. In addition to addressing the changing definition of quality, Lehr discusses the challenges to maintaining quality in a competitive and deregulatory environment. According to Lehr, coordination and cooperation are important ingredients for quality in a network industry such as telecommunications. However, as control over the infrastructure is decentralized, responsibility over guaranteeing system quality and reliability are also decentralized. This complicates the task of providing quality service because many companies with competing incentives, different approaches to quality, and different financial resources each contribute to overall telephone quality.

Richters and Dvorak (1988) present the earliest expansion of the quality concept applicable to the telephone industry. To begin, the authors propose an end-to-end framework for considering telephone quality. Quality should encompass all features associated with telephone service that consumers interact with. This is how consumers experience quality-of-service. Richters and Dvorak propose this approach because they argue that quality-of-service is viewed by the vast majority of consumers as consisting of more than just a single network parameter. To implement the end-to-end framework, the authors develop a matrix. First, the authors identify all the communications functions that consumers experience as part of the end-to-end telephone service. These communications functions consist of (1) technical sales and planning, (2) provisioning of service, (3) technical quality of the telephone service, (4) billing, (5) network/service management by
the consumer, (6) repair, and (7) technical support. Second, the authors identify all performance criteria used by consumers to evaluate telephone service. The performance criteria the authors identify include speed, accuracy, availability, reliability, security, simplicity, and flexibility. These performance criteria are consistent with the concept of the dimensions of quality discussed earlier. The performance criteria speed, accuracy, reliability, and simplicity are consistent with the generic dimensions of quality identified by other authors. The performance criteria availability, security, and flexibility appear unique to the Richters and Dvorak framework and to the telephone industry. The communications functions and performance criteria form a matrix in the authors’ framework. In each cell of the matrix, performance can be measured and standards established. The Richters and Dvorak framework contains elements of the marketing-based and operations research-based paradigms. The framework is marketing-based because it adopts an end-to-end consumer focus and includes as a component consumer surveys and interviews to identify the most important cells in the matrix. Thus, there is a distinctly external focus. The framework is operations research-based because a component involves network compliance with standards. Thus, the Richters and Dvorak framework is an early, comprehensive approach to examine quality in the telephone industry.

Oodan, Ward, and Mullee (1997) extend the framework developed by Richters and Dvorak. The authors note that in the past the telephone industry was driven by technology and not consumer preferences or requirements. Again, this implies that quality-of-service in the telephone industry was associated with the technical performance
of the network as Lehr and Richters and Dvorak also indicated. Oodan, Ward, and Mullee develop a broader definition of quality for the telephone industry that includes two important aspects. First, the authors’ definition adopts an end-to-end consumer focus. This is consistent with the Richters and Dvorak framework. Second, the authors’ definition makes a distinction between the consumer context and the company context. Thus, the authors’ definition consists of two parts. In the consumer context, quality-of-service is defined by the attributes that are considered to be essential in the use of the telephone service by consumers. In the company context, quality-of-service is defined by parameters which contribute towards end-to-end performance of the telephone service. By focusing on both the consumer and company context, the authors incorporate both an external (i.e., consumer) and internal (i.e., company) component. With a broad definition of quality, the authors propose a “quality cycle” to explain quality-of-service in the telephone industry. The cycle begins with the consumers’ quality-of-service requirements. These quality-of-service requirements are a statement of parameters and the level of quality necessary to fulfill the consumers’ needs. The cycle continues with the quality-of-service expected to be provided by the company. The alignment gap identifies the difference between the quality-of-service consumers’ require and the quality-of-service the company expects to provide. The next stage in the cycle is the quality-of-service delivered by the company. The execution gap measures the difference between the expected and actual quality-of-service. Finally, the consumers’ perception of the quality-of-service provided by the company is the last stage in the cycle. The perception gap is the difference between the actual and perceived quality-of-service. The value gap is the
difference between the consumers’ perception of the quality-of-service and their quality-of-service requirements. The Oodan, Ward, and Mullee framework contains elements of both the marketing-based and operations research-based paradigms. The framework is marketing-based in the end-to-end consumer focus, the identification of the gap between consumers’ quality-of-service requirements and the quality-of-service expected to be provided by the company (i.e., the alignment gap), and the identification of the gap between the consumers’ quality-of-service requirements and the consumers’ perception of quality-of-service (i.e., the value gap). At the same time, the framework is operations research-based in the acknowledgment of a gap between the expected and actual quality-of-service provided by the company (i.e., the execution gap).

3.2.4. A Framework for Local Telephone Quality-of-Service

For the theoretical and empirical chapters to follow in this dissertation, I propose a framework to evaluate quality-of-service in the telephone industry. This dissertation considers the incentives to provide quality-of-service in the local telephone industry in several different environments. These environments include the monopoly, dominant firm - competitive fringe, and regulatory environments. A major hypothesis of this dissertation is that the incentives to provide quality-of-service will be different in each environment and combination of environments. At the same time, the trend in the literature reflects a broadening of the definition of quality and of the functions and services that should be considered for an appropriate evaluation of the local telephone quality-of-service. In the
telephone industry, these functions and services include pre-service activities, the telephone network and service provision activities, and post-service activities. Thus, I need a framework that considers the different economic incentives to provide quality-of-service and the many aspects of local telephone service. In addition, the framework should incorporate elements from the three major paradigms discussed previously, thereby including internal versus external, objective versus subjective, and timeless versus socially determined elements.

I propose a framework with two components. The first component is the nature of the service. In my framework, the local telephone service can be either equipment and system oriented or people and process oriented. Equipment and system oriented service quality consist of activities directly related to the telephone network. To provide equipment and system oriented service quality, the local telephone company must invest in network assets. This can include upgrading facilities with fiber optic cable and digital switches or ensuring that sufficient network resources are available (e.g., there are sufficient switching resources per access line). People and process oriented service quality consist of activities that support and augment services provided over the telephone network. To provide people and process oriented service quality, the local telephone company must invest in staff, both in quantity and training, and internal processes. This can include maintaining a sufficient number of engineers to install and repair service as well as continually training the engineers for advances in technology. In addition to engineering staff, people and process oriented service quality requires investment in other operations (e.g., operator, directory assistance) and support (e.g., billing) staff. The
distinction between equipment and system oriented service quality and people and process oriented service quality is important because the economic incentives to provide quality are different for each. The equipment and system oriented service quality requires a long-term investment in physical assets. In the economics literature, investment in long-term physical assets can have strategic purposes for blockading entry, deterring entry, or accommodating entry (Tirole 1988). People and process oriented service quality requires a shorter-term investment in people and internal process. Strategic incentives that influence competitive entry are different when assets are not long-term, much less when the assets can leave without the company's control.

The second component of my framework is the nature of the evaluation of the quality-of-service. The evaluation of the quality-of-service can be either objective or subjective. The evaluation is objective when informed parties can agree on the measure and the relative performance while the evaluation is subjective when informed parties can disagree on the measure and the relative performance. The distinction between objective and subjective evaluation is important because the paradigms explained previously provide no clear guidance. The economics and operations research-based paradigms suggest that quality is objective while the marketing-based paradigm suggests that quality is subjective. By considering both the objective and subjective aspects of quality, my framework incorporates aspects from each of the major paradigms. Thus, the framework is holistic.

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65 Greenstein, McMaster, and Spiller (1995) and Lee (1997) examine the incentives of local telephone companies to invest in modern infrastructure. By investing in modern infrastructure, the local telephone company can be interpreted as improving the equipment and system oriented quality.
My framework provides a means for the theoretical and empirical analysis of a local telephone company’s incentive to provide quality-of-service. Table 3.1 illustrates the framework. In the first row, the equipment and system oriented service quality can be either objective or subjective. Examples of equipment and system oriented service quality measures include the percent of access lines served by digital switches (objective) and consumers’ satisfaction with voice clarity over the network (subjective). Similarly, the people and process oriented service quality can be either objective or subjective. Examples of people and process oriented service quality measures include the average installation interval (objective) and consumers’ satisfaction with operator response times (subjective). The framework accomplishes two goals. First, the framework is not narrow. It incorporates the many aspects of local telephone service and definitions of quality. Second, the framework recognizes the different incentives to provide quality-of-service in the local telephone environment. To understand quality-of-service in the local telephone industry, a framework should incorporate the different incentives to invest in long-term physical assets versus short-term mobile assets. Just because a company heavily invests in network facilities and improves equipment and system oriented service quality does not imply that the company will invest in staff and training. Alternatively, a company with poor equipment and system oriented service quality may invest heavily in staff and training. In general, investment in one type of quality does not imply investment in the other. The following two chapters will exploit aspects of this framework for the theoretical and empirical analysis of local telephone quality-of-service.
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<tr>
<th>Nature of Quality</th>
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<td>Equipment and System</td>
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<tr>
<td>People and Process</td>
<td>e.g., average installation interval</td>
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Table 3.1: Framework for local telephone quality-of-service.
CHAPTER 4

A THEORY OF MONOPOLY AND COMPETITION, QUALITY, AND REGULATION

In this chapter, I provide a theoretical examination of a firm's incentive to provide people and process oriented quality\(^6\) in a monopoly environment and a dominant firm - competitive fringe environment, both environments with and without regulation. For this analysis, I consider a firm that offers a single level of quality to all consumers. First, I examine a monopolist's incentive to provide quality. Several authors have shown that a monopolist will generally distort quality from the socially optimal level of quality. I examine how the monopolist will alter its quality when regulation is imposed. My analysis indicates that the impact of regulation on the monopolist's quality selection depends on the type of regulation imposed. Second, I examine a dominant firm's incentive to provide quality. No literature addresses quality in a dominant firm - competitive fringe environment where the dominant firm offers a single level of quality to all consumers. My

\(^{6}\) Throughout this chapter, reference to quality implies people and process oriented quality. As was mentioned in chapter 3, quality consists of an equipment and system oriented component and a people and process oriented component. The distinction is important because the incentives to provide each type of quality are different. In my framework, equipment and system oriented service quality is an extension of the literature addressing infrastructure investment.
analysis indicates that the presence of a competitive fringe can induce a dominant firm, a former monopolist, to either improve or lower its quality. Furthermore, regulation imposed in the monopoly environment may or may not influence the dominant firm in the new, competitive environment.

4.1. The Monopoly, Quality, and Regulation Environment

In this section, I examine the relationship between monopoly, quality, and regulation. The topic of monopoly and quality began to appear in the literature in the 1970’s and was an extension of the well established monopoly - quantity distortion literature. Researchers in the 1970’s showed that a monopolist will generally distort quality from the socially optimal level of quality. How will a monopolist’s price - quality choice change as regulation is imposed, such as that most prevalent in the local telephone industry? From the unregulated monopolist’s profit maximizing price - quality choice, I find that (1) quality regulation will improve quality, (2) the impact of price regulation and rate-of-return regulation is uncertain, and (3) price regulation combined with quality regulation will improve quality.
4.1.1. Literature Review

In the 1970's, the subject of monopoly and quality began to appear in the literature. The monopolist's price - quantity outcome was the primary concern prior to this time. The result is well known. The monopolist is predisposed to reduce quantity supplied and raise price. In a perfectly competitive environment, the market price equals marginal and average cost of production. Social resources are allocated to their most efficient use and production costs are minimized in this environment.  

With a monopoly environment, price will in most instances exceed marginal and average cost of production. The monopolist reduces the quantity supplied to maximize profits. By reducing quantity, the result is a market price above marginal cost. This quantity and price distortion creates a social welfare loss as fewer units are consumed. The focus on quality is an extension of the literature on monopoly distortion. There are three streams to this literature: durability, a monopolist offering a single level of quality, and a monopolist offering an array of quality levels.

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57 These conditions are allocative and production efficiency, respectively.

58 If the demand for the monopolist's product is perfectly elastic (i.e., there is a horizontal demand curve), the monopolist's price will equal marginal and average cost of production. In addition, the contestability literature suggests that potential competitors can induce a monopoly outcome with average cost pricing (Baumol, Panzar, and Willig 1982).

59 In addition to the efficiency considerations, there are also equity concerns arising from the monopoly quantity distortion. Namely, consumers will pay a higher price for each unit consumed representing a decrease in consumer surplus and an increase in monopoly profits.
Durability was the first stream of the monopoly-quality outcome to appear in the literature. As was mentioned in chapter 3, durability is a dimension of quality associated with the economics-based paradigm of quality. The definition of quality as durability had important implications for the analysis and the conclusions reached. Namely, high quality implied long durability that translated into a longer flow of benefits derived from the product. A very common example is the light bulb. A more durable light bulb produces more hours, or units, of light, the good or service that consumers desire. Swan (1970) is the most cited article in this stream of literature. In Swan's analysis, consumers desire a composite good (e.g., hours of light). The composite good is measured by quantity times durability. To derive the optimal level of durability, Swan assumes that a social planner seeks to maximize social welfare, defined as the area under the demand curve (D) less production cost (C). This goal is accomplished through the minimization of the cost of durability. Swan compares this outcome with a profit maximizing monopolist's outcome. Swan shows that the profit maximizing monopolist will also seek to minimize the cost of durability. Thus, there is no monopolist distortion of quality, if quality is measured as durability. Both a social planner seeking to maximize social welfare and a monopolist

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70 This stream of literature assumes that consumers are purchasing a flow of services. There is no intrinsic value in the product itself beyond the flow of services it provides. Again, this is consistent with the economics-based paradigm of quality and Lancaster's (1966) goods characteristics approach.

71 Other articles addressing quality as durability include Levhari and Srinivasan (1969), Schmalensee (1970), Kamien and Schwartz (1974), and Auernheimer and Saving (1977).
seeking to maximize profits will seek to minimize the cost of durability. This is referred to as the invariance theorem. Swan’s results hold if (1) consumers’ only concern is the composite good and (2) there are constant returns to scale.

One attempt to generalize on the quality as durability literature focuses on a monopolist selecting a single quality level to offer all consumers from a range of possible quality levels. Rather than focus on durability, this line of research focuses on quality generically defined. Quality can take the form of a scalar or vector. However, the firm offers only one quality level, either a scalar or a vector, equally to all consumers selected from a range of possible quality levels. The monopolist is assumed to select a quality level to maximize profits. Spence (1975) and Sheshinski (1976) are the seminal articles in this stream of the monopoly - quality literature. Both independently arrive at a similar result. Namely, the monopolist will generally distort quality.

Spence and Sheshinski both compare a social planner and a profit maximizing monopolist to illustrate the quality distortion. For the optimal quality level, a social planner is assumed to maximize social welfare, the area under the demand curve less production cost, just as in Swan’s analysis. The optimal quantity (X) - quality (q) vector (X*,q*) that maximizes total surplus satisfies two conditions: $D_x = C_x$ and $D_q = C_q$.  

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72 As a scalar, the quality level is applied equally to all aspects of service. For example, the local telephone monopolist could supply a “high” level of quality to all aspects of the local telephone service. As a vector, different quality levels can be applied to different aspects of service. Again considering a local telephone monopolist, the firm could supply a “high” level of installation and repair quality but a “moderate” level of consumer service and billing quality. In both instances, the quality level is provided equally to all consumers.

73 Throughout this chapter, subscripts will denote derivatives and partial derivatives.
These conditions imply that the marginal change in demand equals the marginal change in production cost for quantity and quality, respectively. The social planner will alter both quantity and quality until the incremental change in demand equals the incremental change in production cost for both quantity and quality. This will maximize social welfare. Social resources are dedicated to their most efficient use. On the other hand, the monopolist is assumed to maximize profits (π), or revenue (R) less production cost. The quantity-quality vector (X^m, q^m) that maximizes profit satisfies two conditions: R_x = C_x and R_q = C_q. These conditions imply that the marginal change in revenue equals the marginal change in production cost for quantity and quality, respectively. The monopolist will alter both quantity and quality until the incremental change in revenue equals the incremental change in production cost for both quantity and quality, where profits will be maximized.

According to Sheshinski, the “[m]onopolist’s profit maximizing decisions will always deviate from the social optimum.” In general, there will be two distortions: a quantity distortion and a quality distortion. The well-known quantity distortion was mentioned previously. The quality distortion depends on the elasticity of demand and the change in the marginal value of quality with a change in quantity (P_q). Namely, as additional units are sold, how does the marginal consumer’s valuation of quality change? Spence presents a table that illustrates how the optimum compares to the monopolist’s choice.

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75 Price represents a consumer’s willingness to pay, or valuation. P_q is the change in this willingness to pay brought about by a change in quality, or the marginal valuation of quality. P_q explains how the marginal valuation of quality will change with quantity.

76 Consider a scenario where each consumer purchases a single unit. P_q is negative when each new consumer’s willingness to pay for quality is lower than the previous consumer’s willingness to pay. P_q is
<table>
<thead>
<tr>
<th>Elasticity of Demand</th>
<th>$P_{sq} &lt; 0$</th>
<th>$P_{sq} &gt; 0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inelastic Demand</td>
<td>Above</td>
<td>Below</td>
</tr>
<tr>
<td>Elastic Demand</td>
<td>Below</td>
<td>Above</td>
</tr>
</tbody>
</table>

Table 4.1: Optimal quality level versus profit maximizing quality level (Spence 1975).

The local telephone industry most likely falls into the upper left quadrant, the optimal level of quality will be above a profit maximizing monopolist’s quality selection. This occurs because demand is relatively inelastic and inframarginal consumers’ valuation of quality most likely exceeds the marginal consumer’s valuation of quality. Both Spence and Sheshinski also briefly consider regulation. Spence compares the optimal quality level to that of a monopolist under rate-of-return regulation. He finds that rate-of-return regulation could bring the monopolist’s quality selection closer to the optimum level. Sheshinski compares price and quality regulation with the optimal quality level. He shows that the price regulation outcome depends on the change in the

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positive when each new consumer’s willingness to pay for quality is higher than the previous consumer’s willingness to pay.

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77 Hausman, Tardiff, and Belinfante (1993) estimate the basic access price elasticity for measured rate service at -0.0052. Park, Wetzel, and Mitchell (1983) also find that the price elasticities for local telephone calls and minutes of conversation are “fairly small.”

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78 While inframarginal consumers could have a lower valuation for quality than marginal consumers in some industries, this is unlikely in the local telephone industry. The most intensive users of local telephone service, those with the greatest demand, are generally business consumers. A report by the National Regulatory Research Institute found that business/non-residential consumers in Ohio were consistently more concerned about quality-of-service problems than were residential consumers (Lawton 1996). This indicates that inframarginal consumers have a higher valuation of quality than do marginal consumers.
monopolist’s marginal revenue and marginal cost from a change in quality \( (R_{xq} - C_{xq}) \).\(^{79}\) If the above is negative, the monopolist will decrease quality. If the above is positive, the outcome is unclear.

Saving (1982) employs a different approach to examine the possible quality distortion by a monopolist. According to Saving, “it is the difference between monopoly and competition in equilibrium that must form the basis for analysis of the effect of market organization on product quality.”\(^{80}\) Saving relies on the theory of joint demand and supply for his analysis. To begin, Saving derives the supply side price - quality function. He shows that the function will be the same for both a monopolist and a competitive firm.\(^{81}\) Next, Saving derives the iso-demand functions for a monopolist and a competitive firm. It is here that differences between the monopolist and competitive firms can arise. The iso-demand functions will be the same only if demand is separable. For example, demand is separable when quality is considered durability (i.e., the Swan case). Thus, Saving’s analysis supports the conclusions of both Swan and Spence and Sheshinski.

In the third stream of the monopoly - quality literature, researchers focused on a monopolist offering a range of quality choices to consumers. Again, quality was conceived of generically. However, rather than selecting a single quality level to provide to all consumers, the monopolist can select several quality levels (e.g., “high,” “medium,”

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\(^{79}\) \( R_x \) and \( C_x \) are marginal revenue and marginal cost, respectively. \( R_{xq} \) explains how marginal revenue changes with quality. \( C_{xq} \) explains how marginal cost changes with quality.

\(^{80}\) Saving (1982): 858.

\(^{81}\) This result relies on the assumption that all firms have the same cost functions (i.e., each entrant has the same costs as existing firms in the market).
and "low") to provide to consumers. Mussa and Rosen (1978) is the seminal article in this stream of the monopoly-quality literature. In their model, quality is a scalar, costs increase with quality $C_q > 0$ and $C_{qq} > 0$, costs are constant with quantity, and consumers purchase one unit. In addition, consumers have the following utility function: $U = \Theta q - P$ where $U$ is total utility, $P$ is price, and $\Theta$ is the consumer's willingness to pay for quality.

Figure 4.1 provides an example with two consumers, one with a high demand for quality ($\Theta^H$) and one with a low demand for quality ($\Theta^L$). The lines $\Theta^H$ and $\Theta^L$ are isoultility lines where the consumer's utility is constant. A isoultility line identifies all combinations of price and quality where utility is the same. The consumer would be indifferent between all combinations of price and quality located on the isoultility line. The consumer with a high demand for quality has a steep slope to the isoultility line while a consumer with a low demand for quality has a flat slope to the isoultility line. This indicates that the consumer with a high demand for quality will pay a higher price at every quality level than the consumer with a low demand for quality. A monopolist that can perfectly discriminate between consumers will offer the consumer with a high demand for quality vector $a$ and the consumer with a low demand for quality vector $b$. In this instance, both consumers have zero utility. This is represented by the fact that their isoultility lines, when drawn through vectors $a$ and $b$, will also pass through the origin. The monopolist has

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82 This is consistent with the economics-based paradigm of quality. Spence and Sheshinski also assume that costs increase with quality.

83 The slope of the isoultility line is $\Theta = (U+P)/q$. With utility set equal to zero, $\Theta = P/q$ and the isoultility line passes through the origin. Isoultility lines with vertical intercepts below the origin are associated with positive utility.
appropriated all the consumer surplus. However, this equilibrium is not sustainable. The consumer with a high demand for quality will have higher utility at vector b than at vector a. This is seen with the high demand consumer's isutility line drawn through vector b.

The isutility line crosses the vertical axis below the origin implying positive utility. As Mussa and Rosen note, the presence of vector b interferes with the monopolist's ability to charge higher prices to the consumer with a high demand for quality. Thus, the monopolist must offer the consumer with a low demand for quality a sufficiently poor price-quality vector such that the consumer with a high demand for quality will not choose that vector.

![Diagram](image)

Figure 4.1: Monopolist offering multiple quality options facing two consumers.
Several authors make additional contributions to this stream of the literature. White (1977) provides a slightly different analysis than Mussa and Rosen, yet arrives at a similar conclusion. White shows that the degree to which the monopolist will distort the price-quality vector depends on (1) the form of the utility function, (2) the technology (i.e., shape of the cost function), and (3) the number of consumers. According to White, unlike a competitive industry that provides optimal quality varieties, a monopolist may provide non-optimal quality varieties in response to minority tastes. This implies that the traditional welfare effects of monopolies (i.e., the quantity distortion) understate the negative impact of monopolies. Additionally, Besanko, Donnenfeld, and White (1988) incorporate regulation into this environment. They show that minimum quality standards increase quality provided to consumers with low demand for quality, without a change in the quality offered to consumers with a high demand for quality. Maximum price restraints also increase the quality provided to consumers with low demand for quality while reducing quality offered to consumers with high demand for quality. Rate-of-return regulation will increase the quality provided to both types of consumers if quality is capital intensive.

4.1.2. Unregulated Monopolist

A natural place to begin the analysis of monopoly, quality, and regulation is the unregulated monopolist. An unregulated monopolist will select a price-quality vector that maximizes profit. This would be the outcome without government regulation of
quality, price, or rate-of-return. The analysis below assumes that the monopolist provides a single quality level selected from a range of quality levels equally to all consumers. Of the three streams of the monopoly - quality literature, this model most closely mirrors the local telephone industry.\textsuperscript{84}

To begin the analysis, I define the market demand and cost characteristics.\textsuperscript{85} Market demand ($X$) is assumed to be a function of price ($P$) and quality ($q$). Demand and price are negatively related, as is consistent with economic theory. Demand and quality are positively related.\textsuperscript{86} This implies that quantity demand increases with higher quality, holding price constant. These conditions are outlined below.

\[ X = X(P, q) \] \hfill (4.1)

\[ X_P < 0 \quad X_q > 0 \]

\textsuperscript{84} The model where the monopolist provides a range of quality options to consumers is the next most appropriate model for the local telephone industry. However, several factors make it less appropriate than the model where a monopolist provides all consumers with a single quality level. First, while the local telephone monopolist can offer different quality levels for certain aspects of service (e.g., advanced services), quality associated with other aspects is generally consistent across consumers. Second, the model of a range of quality assumes that consumers self-select, this is the reason for the quality distortion. But, with local telephone service, consumers are clearly identified by type (e.g., residential and business) and cannot switch. Third, this is the way that regulators typically view their responsibilities with respect to quality standards.

\textsuperscript{85} The analytical framework developed here follows that of Sheshinski (1976). However, rather than assuming that the monopolist selects quantity and quality, I choose to consider a monopolist selecting price and quality.

\textsuperscript{86} This condition holds whether the evaluation of quality is objective or subjective, as discussed in chapter 3. However, the magnitude of $q$ could be different, which will influence demand.
Cost \( (C) \) is assumed to be a function of quantity and quality. Since quantity is a function of price and quality, cost is indirectly a function of these variables also. Consistent with the literature, I assume that costs increase with both quantity and quality. These conditions are illustrated below.

\[
C = C(X, q) \tag{4.2}
\]

\[
C_X > 0 \quad C_q > 0
\]

Both the demand and cost functions are general, there is no specific functional form (e.g., linear demand) attached to the analysis.

With the demand and cost functions defined, I can solve for the unregulated monopolist’s price - quality vector. The following objective function is the monopolist’s problem. This objective function assumes that the monopolist maximizes profit \( (\pi) \), revenue minus costs, with the selection of price and quality. Revenue is defined as price times quantity, or \( PX(P, q) \), while cost is defined as a function of quantity and quality, or \( C[X(P, q), q] \), as mentioned above.

\[
\text{Max } \pi(P, q) = PX(P, q) - C[X(P, q), q] \tag{4.3}
\]

This is an unconstrained maximization problem since the monopolist is unregulated, with the assumption that price and quality are positive. Because the monopolist is selecting
both price and quality simultaneously to maximize profits, the monopolist solves two first order conditions. These first order conditions are the marginal change in profit associated with a change in price ($\pi_p$) and the marginal change in profit associated with a change in quality ($\pi_q$).

$$\pi_p = X(P,q) + PX_p(P,q) - C_XX_p(P,q) = 0 \quad (4.4)$$

$$\pi_q = PX_q(P,q) - C_XX_q(P,q) - C_q(X,q) = 0 \quad (4.5)$$

Equation 4.4 implies that the monopolist will alter price until the change in profit is zero, holding quality constant. Equation 4.5 implies that the monopolist will alter quality until the change in profit is zero, holding price constant. To assure that profits are maximized and not minimized, the following second order condition must hold.\(^{87}\)

$$H = \begin{vmatrix} \pi_{pp} & \pi_{pq} \\ \pi_{qp} & \pi_{qq} \end{vmatrix} > 0 \quad (4.6)$$

$$\pi_{pp} < 0 \quad \pi_{qq} < 0$$

\(^{87}\) This condition implies that the determinant of the Hessian matrix, a matrix of second-order partial derivatives, is positive (Silberberg 1990, 175).
To illustrate the solution of the unregulated monopolist’s price-quality outcome, I follow the graphical approach of Sheshinski (1976). The solution of two equations in two unknowns occurs where the lines of the two equations intersect. In this instance, the unregulated monopolist’s profit maximizing price-quality vector occurs where the graph of the two first order conditions, \( \pi_p = 0 \) and \( \pi_q = 0 \), intersect in price-quality space. To identify this vector, I derive the slope of the two first order conditions, \( \pi_p = 0 \) and \( \pi_q = 0 \).

Consider first the slope of the equation \( \pi_p = 0 \). Using the total differential, the slope of the first order equation \( \pi_p = 0 \) is as follows.

\[
\frac{dP}{dq} \bigg|_{\pi_p=0} = -\left(\frac{\pi_{pq}}{\pi_{pp}}\right) \\
= -\frac{(X_q + PX_{qp} - C_{XX}X_pX_q - C_{Xq}X_q - C_{qq}X_q)/(2X_p + PX_{pp} - C_{XX}X_{pp})}{(X_q + PX_{qp} - C_{XX}X_pX_q - C_{Xq}X_q - C_{qq}X_q)/(2X_p + PX_{pp} - C_{XX}X_{pp})}
\]

(4.7)

From the second order condition, the denominator \( \pi_{pp} \) is negative. Thus, the slope of the first order equation \( \pi_p = 0 \) depends on the sign of \( \pi_{pq} \). The same analysis can be applied to the first order equation \( \pi_q = 0 \). The slope of this first order equation is as follows.

\[
\frac{dP}{dq} \bigg|_{\pi_q=0} = -\left(\frac{\pi_{pq}}{\pi_{qp}}\right) \\
= -\frac{(PX_{q} - C_{XX}X_{q} - C_{qq})/(X_q + PX_{qp} - C_{XX}X_pX_q - C_{Xq}X_q - C_{qq}X_q)}{(PX_{q} - C_{XX}X_{q} - C_{qq})/(X_q + PX_{qp} - C_{XX}X_pX_q - C_{Xq}X_q - C_{qq}X_q)}
\]

(4.8)
From the second order condition, the numerator (π_{qq}) is negative. Thus, the slope of the first order equation \( \pi_q = 0 \) depends on the sign of \( \pi_{qp} \). In both instances, the slope of the first order equation depends on the sign of \( \pi_{qp} = \pi_{pq} \). These are equivalent by Young's Theorem. These second derivatives explain how the marginal rate of change in profit associated with price will change when quality is increased or decreased, at a given price and quality vector.

Because the slopes of both first order conditions depend on the sign of partial derivatives that are equivalent, there are two possible scenarios. In the first scenario, \( \pi_{qp} = \pi_{pq} \) is positive. With an increase in quality, the monopolist's profit maximizing price level will increase. This implies that inframarginal consumers are willing to pay more for quality than are marginal consumers. The monopolist can increase profits by improving quality and raising its price, where inframarginal consumers will continue to purchase while some marginal consumers will discontinue purchasing. As a result, the slope of both \( \pi_p = 0 \) and \( \pi_q = 0 \) are positive from equation 4.7 and equation 4.8. The next factor to consider is the relative slope of \( \pi_p = 0 \) and \( \pi_q = 0 \). The following analysis shows that the slope of \( \pi_q = 0 \) is greater than the slope of \( \pi_p = 0 \).

\[
(Slope \ \pi_p = 0) - (Slope \ \pi_q = 0) = \left[ -\frac{\pi_{pq}}{\pi_{pp}} \right] - \left[ -\frac{\pi_{qq}}{\pi_{qp}} \right] \\
= \frac{\pi_{pp} \pi_{qq} - \pi_{pq}^2}{\pi_{qp}^2 \pi_{pp}} \tag{4.9}
\]

\(^{88}\) According to Young's Theorem, if a function has second-order partial derivatives that exist and are continuous, then the second-order partial derivatives will be equal (Silberberg 1990, 74).
Equation 4.9 is negative, because the numerator \((\pi_{pp} \pi_{qq} - \pi_{pq}^2)\) is positive, based on the second order condition, and the denominator \((\pi_{pq} \pi_{pp})\) is negative, based on the second order condition \((\pi_{pp})\) and the assumed sign of \(\pi_{pq}\) in this scenario.\(^{89}\) Thus, the slope of \(\pi_q = 0\) is greater than the slope of \(\pi_p = 0\) since both have positive slopes. Figure 4.2 illustrates the unregulated monopolist’s price - quality \((P^M, q^M)\) selection under this scenario.

![Diagram](image)

Figure 4.2: Unregulated monopolist’s price - quality selection when \(\pi_{pq} = \pi_{pq}^*\) is positive.

\(^{89}\) The numerator is positive because \(\pi_{pq} \pi_{qq} - \pi_{pq}^2\) is the algebraic expression for the determinant in the second order condition of equation 4.6, which is positive for profit maximization. The denominator is negative because \(\pi_{pq}\) is positive by assumption and \(\pi_{pp}\) is negative from the second order condition.
To better explain the impact of the regulatory policies to follow, I will illustrate the three dimensional profit, price, and quality ($\pi, P, q$) nature of figure 4.2 and the corresponding isoprofit level curves. Figure 4.3 illustrates the three dimensional representation of figure 4.2 with profit included. The profit “hill” is highest where the two first order conditions, $\pi_P = 0$ and $\pi_q = 0$, intersect.\textsuperscript{90} This identifies the point in price-quality space where profits are maximized. In figure 4.3, the profit “hill” is pictured as a quasi-concave function.\textsuperscript{91} However, the exact form is not relevant for the analysis. The only requirement is a single maximum point in the relevant domain, where price and quality are positive.

\textsuperscript{90} Train (1991) was the first author to incorporate this type of analysis in the regulatory economics literature.

\textsuperscript{91} Silberberg (1990), 177-178.
Figure 4.3: Unregulated monopolist's price - quality selection with profit when \( \pi_{qP} = \pi_{Pq} \) is positive.

Figure 4.3 can be converted into a two dimensional figure with price and quality (P,q), where isoprofit level curves correspond to different levels of profit. The isoprofit level curves illustrate all combinations of price and quality where profit is the same. Thus, the firm would be indifferent between any combinations of price and quality that are on the same isoprofit level curve. Figure 4.4 illustrates the isoprofit level curves for figure 4.3 where \( \pi_{qP} = \pi_{Pq} \) is positive. Isoprofit level curves closer to the intersection of \( \pi_p = 0 \) and \( \pi_q = 0 \) correspond to higher profit levels.
Figure 4.4: Unregulated monopolist’s isoprofit level curves when $\pi_{qP} = \pi_{Pq}$ is positive.

In the second scenario, $\pi_{qP} = \pi_{Pq}$ is negative. With an increase in quality, the monopolist’s profit maximizing price level will decrease. This implies that inframarginal consumers are willing to pay less for quality than are marginal consumers. As a result, the slope of both $\pi_p = 0$ and $\pi_q = 0$ are negative from equation 4.7 and equation 4.8. The next factor to consider is the relative slope of $\pi_p = 0$ and $\pi_q = 0$. The following analysis shows that the slope of $\pi_p = 0$ is greater than the slope of $\pi_q = 0$.

\[
\text{(Slope } \pi_p = 0) - \text{(Slope } \pi_q = 0) = \left[ -\left( \frac{\pi_{pq}}{\pi_{PP}} \right) \right] - \left[ -\left( \frac{\pi_{qp}}{\pi_{qq}} \right) \right] \\
= \frac{(\pi_{pp}\pi_{qq} - \pi_{pq}^2)(\pi_{QP}\pi_{PP})}{\pi_{Pq}^2} \quad (4.10)
\]
Equation 4.10 is positive, because numerator is positive, based on the second order conditions, and the denominator is positive, based on the second order conditions \( \pi_{PP} \) and the assumed sign of \( \pi_{qP} \) in this scenario. Thus, the slope of \( \pi_P = 0 \) is greater than the slope of \( \pi_q = 0 \) since both have negative slopes. Figure 4.5 illustrates the unregulated monopolist’s price-quality \( (P^M, q^M) \) selection under this scenario.

Figure 4.5: Unregulated monopolist’s price-quality selection when \( \pi_{qP} = \pi_{Pq} \) is negative.

For this scenario, I will simply illustrate the isoprofit level curves. There is no significant difference in the profit “hill” illustrated in figure 4.3 and one constructed for this scenario. Unlike figure 4.4, the isoprofit level curves slope from the upper left to the
lower right in this scenario. This is a reflection of the change in the first order conditions
\( \pi_P = 0 \) and \( \pi_q = 0 \). Again, profits will be highest, at \( (P^M, q^M) \), where these two equations intersect.

![Graph showing isoprofit curves]

Figure 4.6: Unregulated monopolist’s isoprofit level curves when \( \pi_{qP} = \pi_{Pq} \) is negative.

This concludes the analysis of an unregulated monopolist’s price - quality outcome. The monopolist will select a price - quality vector that simultaneously solves the two first order conditions and thus maximizes profits. While the outcomes appear similar for the two scenarios, the slope of the isoprofit level curves will have implications for the quality decision when regulation is present. In the next subsection, I incorporate quality regulation.
4.1.3. Monopoly with Quality Regulation

Concerns about the efficiency and equity problems associated with a monopolist's choice of quality can justify government regulation of quality. As Spence (1975) and Sheshinski (1976) indicate, an unregulated monopolist will generally not set an optimal level of quality. In the local telephone industry, Spence's analysis implies that an unregulated monopolist will generally select an inefficiently low level of quality. Also, Mussa and Rosen (1978) indicate that an unregulated monopolist will discriminate between consumers on the basis of their willingness to pay for quality. As a result, at least forty-three state public utility commissions imposed some form of quality-of-service regulation in 1998 (Clements and Davis 1998). Thus, it is important to understand how quality regulation will influence a monopolist's price-quality decision.

The monopolist subject to quality regulation will solve the following objective function. This objective function assumes that the monopolist maximizes profits with the selection of price and quality, subject to the constraint that quality must exceed the minimum regulated quality level \( q^R \).

\[
\begin{align*}
\max_{P,q} \pi(P,q) &= PX(P,q) - C[X(P,q),q] \quad \text{s.t.} \quad q \geq q^R
\end{align*}
\] (4.11)

If we accept the public interest theory of regulation discussed in chapter 2, it must be the case that the minimum regulated quality level \( q^R \) exceeds the unregulated monopolist's
quality selection ($q^M$). The analysis below will show that the minimum regulated quality level will be a binding constraint. Namely, the monopolist will select the minimum regulated quality level (i.e., $q = q^R$).

I first consider the scenario where $\pi_{qp} = \pi_{pq}$ is positive. Figure 4.7 illustrates the minimum regulated quality level $q^R$ and the isoprofit level curve. Notice that the minimum regulated quality level $q^R$ exceeds the unregulated monopolist’s quality selection $q^M$, consistent with the public interest theory of regulation.

Figure 4.7: Monopolist with quality regulation where $\pi_{qp} = \pi_{pq}$ is positive.

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92 This condition would not necessarily hold under the capture or interest group theories of regulation also discussed in chapter 2.
From figure 4.7, it is apparent that the monopolist will select quality at the minimum regulated quality level $q^R$. The monopolist will select a price ($P^R$) above the unregulated monopolist’s price ($P^M$).\textsuperscript{93} By raising the quality level in this scenario, inframarginal consumers are willing to pay more for the good or service. The monopolist is induced to increase price to maximize profits. The monopolist will not select a quality level above $q^R$ because its profits would be lower. This is represented by the lower isoprost level curves at higher quality levels. While the monopolist could provide a higher quality level and charge a higher price, profits will decline because the marginal revenue from an increase in quality will be less than the marginal cost. Because of the minimum regulated quality level, the monopolist cannot provide a quality level below $q^R$. These conditions imply that the monopolist will select a quality level consistent with the minimum regulated quality level. Finally, the monopolist’s profits will be lower than with the unregulated scenario. This is represented by the lower isoprost level curve at the vector ($P^R, q^R$) than at the vector ($P^M, q^M$).

\textsuperscript{93} Section 4.1.5 below will consider the scenario where quality and price are both regulated.
Next, I consider the scenario where $\pi_{q'} = \pi_{Pq}$ is negative. Figure 4.8 illustrates the minimum regulated quality level $q^R$ and the isoprofit level curve.

Figure 4.8: Monopolist with quality regulation where $\pi_{q'} = \pi_{Pq}$ is negative.

From figure 4.8, it is apparent that the monopolist will select quality at the minimum regulated quality level $q^R$. The monopolist will select a price ($P^qR$) below the unregulated monopolist's price ($P^M$). By raising the quality level in this scenario, additional marginal consumers are drawn to the good or service while inframarginal consumers are willing to pay very little additional. This induces the monopolist to reduce price to attract additional consumers to maximize profits. The monopolist will not select a quality level above $q^R$. 

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because its profits would be lower. This is represented by the lower isoprofit level curves at higher quality levels. While the monopolist could provide a higher quality level and charge a lower price and therefore increase demand further, profits will decline because the marginal revenue from an increase in quality will be less than the marginal cost.

Because of the minimum regulated quality level, the monopolist cannot provide a quality level below $q^R$. These conditions imply that the monopolist will select a quality level consistent with the minimum regulated quality level. Finally, the monopolist's profits will be lower than with the unregulated scenario. This is represented by the lower isoprofit level curve at the vector $(P^R, q^R)$ than at the vector $(P^M, q^M)$.

From the above two analyses, it is apparent that minimum regulated quality levels will result in higher quality levels. This is the outcome if we accept the public interest theory of regulation (i.e., $q^R \geq q^M$). Otherwise, the monopolist will simply select $q^M$. The analysis also illustrates the minimum regulated quality level can result in either higher or lower prices, depending on whether marginal or inframarginal consumers have a greater valuation for quality (i.e., the sign of $\pi_{qp} = \pi_{pq}$).

4.1.4. Monopoly with Price Regulation

In response to the monopoly price - quantity distortion, many state public utility commissions impose price regulation. To maximize profits, an unregulated monopolist is predisposed to reduce quantity supplied and raise price. Since price is above marginal cost, the price prevailing in a competitive market, there will be fewer units purchased.
The higher price and lower quantity demand creates a reduction in consumer surplus. This is harmful to consumers. While economic profits are present, the decline in consumer surplus exceeds the additional economic profits and the net effect is a decline in social welfare. As a result of these efficiency and equity considerations, most state public utility commissions impose some form of economic regulation on local telephone monopolies. In recent years, price regulation, taking a variety of forms including price cap and rate freeze,\(^\text{94}\) has become the most prevalent form of economic regulation (Abel and Clements 1998). Thus, price regulation is another important environment in which to consider a monopolist’s quality decision.

The monopolist subject to price regulation will solve the following objective function. The objective function assumes that the monopolist maximizes profit with its selection of price and quality, subject to the constraint that price must not exceed the maximum regulated price level \((P^R)\).

\[
\text{Max } \pi(P,q) = PX(P,q) - C[X(P,q),q] \quad \text{s.t.} \quad P \leq P^R \quad (4.11)
\]

Again, if we accept the public interest theory of regulation, it must be the case that the maximum regulated price level \(P^R\) is less than the unregulated monopolist’s price selection.

\(^{94}\) While price cap and rate freeze regulation have some different attributes, they are both treated generically as price regulation in this chapter because the essential feature of the price setting mechanism is similar in both instances. Namely, an upper limit on price is established, with no restriction on profits as with rate-of-return or earnings sharing regulation.
The analysis below will show that the maximum regulated price level will have a different impact on the monopolist’s quality depending on the sign of $\pi_{qP} = \pi_{pq}$. The slope of the first order conditions and the shape of the isoprot level curves will determine whether a monopolist provides a lower or higher level of quality with a maximum regulated price level than in an unregulated environment.

I first consider the scenario where $\pi_{qP} = \pi_{pq}$ is positive. Figure 4.9 illustrates the maximum regulated price level $P^R$ and the isoprot level curve.

![Diagram](image)

Figure 4.9: Monopolist with price regulation where $\pi_{qP} = \pi_{pq}$ is positive.

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95 Again, this condition would not necessarily hold under the capture or interest group theories of regulation.
From figure 4.9, it is apparent that the monopolist will select quality at level \( q^{PR} \), below the unregulated quality level \( q^M \). By lowering price in this scenario, consumers with a lower willingness to pay for quality, the marginal consumers, are induced to consume the good or service. Additionally, the monopolist cannot charge inframarginal consumers, those willing to pay more for quality, a higher price because of the maximum regulated price level. Thus, the profit maximizing response is to lower quality. If the price is frozen at \( P^R \) (i.e., there is a rate freeze), the monopolist will select quality level \( q^{PR} \). It is at this point that the maximum regulated price level \( P^R \) crosses the first order equation for profit relative to quality (\( \pi_q \)) and is tangent to the isoprofit level curve. Even if the monopolist could lower its price (i.e., there is a price cap), the monopolist will still select quality level \( q^{PR} \) and price \( P^R \). Any different combination of price and quality will result in a lower profit level. Thus, in this scenario, price regulation will result in a quality level below the unregulated monopolist level, which Spence (1975) and Sheshinski (1976) show to be generally inefficiently low to begin with. If we accept the notion that the local telephone industry has demand and cost conditions such that \( \pi_{qp} = \pi_{pq} \) is positive, it is not surprising that most state public utility commissions choose to impose minimum regulated quality levels when they adopt price regulation.\(^{96}\)

\(^{96}\) Section 4.1.5 considers a monopoly environment with both quality and price regulation.
I next consider the scenario where $\pi_{qP} = \pi_{Pq}$ is negative. Figure 4.10 illustrates the maximum regulated price level $P^R$ and the isoprofit level curve.

![Graph showing price and profit levels](image)

Figure 4.10: Monopolist with price regulation where $\pi_{qP} = \pi_{Pq}$ is negative.

From figure 4.10, it is apparent that the monopolist will select quality at level ($q^{PR}$) above the unregulated quality level $q^M$. By lowering price in this scenario, consumers with a higher willingness to pay for quality are induced to consume the good or service. The monopolist can increase revenue by increasing quality and attracting additional demand from consumers who place a higher value on quality. If the price is frozen at $P^R$ (i.e., there is a rate freeze), the monopolist will select quality level $q^{PR}$. It is at this point that
the maximum regulated price level $P^R$ crosses the first order equation for profit relative to quality ($\pi_q$) and is tangent to the isoprofit level curve. Even if the monopolist could lower its price (i.e., there is a price cap), the monopolist will still select quality level $q^{PR}$ and price $P^R$. Any different combination of price and quality will result in a lower profit level. Thus, in this scenario, price regulation will result in a quality level above the unregulated monopolist level.

From the above two analyses, the impact of price regulation is uncertain. The local telephone industry is most likely associated with the environment where $\pi_{QP} = \pi_{Pq}$ is positive. This is because demand is relatively inelastic and inframarginal consumers place a greater valuation on quality than do marginal consumers. The analysis implies that quality will be lower with price regulation in the local telephone industry. This implies that price regulation might need to be combined with quality regulation. The next section considers the combined impact of price and quality regulation.

4.1.5. Monopoly with Price and Quality Regulation

The combination of price and quality regulation is the most prevalent environment in which local telephone companies operate today. A majority of state public utility commissions use some form of a maximum regulated price level and at least forty-three impose some form of minimum regulated quality level (Abel and Clements 1998 and Clements and Davis 1998). The combined implementation of these regulations is not
surprising given the results discussed previously. Thus, it is important to understand what influence these regulations, imposed simultaneously, will have on a monopolist's quality selection versus the unregulated environment.

The monopolist subject to price and quality regulation will solve the following objective function. The objective function assumes that the monopolist maximizes profit with its selection of price and quality, subject to the constraints that (1) quality must exceed the minimum regulated quality level \(q^R\) and (2) price must not exceed the maximum regulated price level \(P^R\).

\[
\max_{P,q} \pi(P,q) = PX(P,q) - C[X(P,q),q] \quad \text{s.t.} \quad P \leq P^R, \quad q \geq q^R
\]  

(4.12)

Again, accepting the public interest theory of regulation, it must be the case that the minimum regulated quality level \(q^R\) exceeds the unregulated monopolist's quality level \(q^N\) and the maximum regulated price level \(P^R\) is less than the unregulated monopolist's price selection \(P^M\). The analysis below will show that both the price and quality constraints will be binding.\(^7\) The monopolist will select price \(P^R\) and quality \(q^R\) in this environment.

\(^7\) Again, this condition would not necessarily hold under the capture or interest group theories of regulation.
I first consider the scenario where \( \pi_{qP} = \pi_{Pq} \) is positive. Figure 4.11 illustrates the maximum regulated price level \( P^R \), the minimum regulated quality level \( q^R \), and the isoprofit level curves. Note that \( P^R \) is less than \( P^M \) and that \( q^R \) is greater than \( q^M \) as suggested by the public interest theory of regulation.

![Diagram](image)

**Figure 4.11:** Monopolist with price and quality regulation where \( \pi_{qP} = \pi_{Pq} \) is positive.

From figure 4.11, it is apparent that the monopolist will select quality level \( q^R \) at price \( P^R \), or point A in the figure. This price-quality vector is associated with the highest isoprofit level curve feasible given the regulatory constraints. The monopolist could feasibly decrease price below \( P^R \) and increase quality beyond \( q^R \). However, these options are not
jointly profit maximizing or individually profit maximizing and feasible because of the regulatory constraints. First, consider jointly decreasing price and increasing quality, a movement to the right and down from point A. With this alternative, the monopolist will move further from the profit maximizing vector \((P^M, q^M)\) and to a lower isoprofit level curve. This implies that profits will decrease by jointly decreasing price and increasing quality. Second, consider decreasing price below \(P^R\). This would induce a decrease in the quality level below \(q^R\) to increase profits. When \(\pi_{qp} = \pi_{pq}\) is positive, a lower price induces lower quality as was shown in section 4.1.4. However, this is not feasible given the minimum regulated quality constraint. Finally, consider increasing quality above \(q^R\). This would induce an increase in price above \(P^R\) to increase profits. When \(\pi_{qp} = \pi_{pq}\) is positive, a higher quality level induces a higher price as was shown section 4.1.3. However, this is not feasible given the maximum price level constraint. Thus, the feasible selection, jointly decreasing price and increasing quality, is not profit maximizing and the profit maximizing selections, decreasing price or increasing quality individually, are not feasible. Since jointly increasing price and decreasing quality, while profit maximizing, is not feasible, this implies that point A is the feasible profit maximizing selection given the regulatory constraints. Both the price and quality constraints are binding. The monopolist's profits are lower than in the unregulated environment or the environment with either price or quality regulation alone. This is represented by the lower isoprofit level curve at the vector \((P^R, q^R)\) than at the vectors \((P^M, q^M)\), \((P^R, q^{PR})\), or \((P^{aR}, q^R)\).
Next, I consider the scenario where \( \pi_{q\pi} = \pi_{pq} \) is negative. Figure 4.11 illustrates the maximum regulated price level \( p^R \), the minimum regulated quality level \( q^R \), and the isoprofit level curve.

![Graph showing regulated price and quality levels](image)

Figure 4.12: Monopolist with price and quality regulation where \( \pi_{q\pi} = \pi_{pq} \) is negative.

From figure 4.12, it is apparent that the monopolist will again select quality level \( q^R \) at price \( p^R \), or point A in the figure. This price-quality vector is associated with the highest isoprofit level curve that is feasible. The monopolist could feasibly decrease price below \( p^R \) and increase quality beyond \( q^R \). However, these options are not jointly or individually profit maximizing. First, consider jointly decreasing price and increasing quality, a
movement to the right and down from point A. The monopolist will move further from
the profit maximizing vector \((P^M, q^M)\) and to a lower isoprofit level curve. This implies
that profits will decrease by jointly decreasing price and increasing quality. Second,
consider decreasing price below \(P^R\). With no quality regulation, a price reduction when
\(\pi_{qp} = \pi_{pq}\) is negative typically will induce an increase in quality, as was shown in section
4.1.4. However, because the monopolist is beginning at \(q^R\), which is above its profit
maximizing quality selection with price regulation \((q^{PR})\), any price reduction will simply
lower the monopolist’s profits and quality remains at \(q^R\). Finally, consider increasing
quality above \(q^R\). With no price regulation, a quality increase when \(\pi_{qp} = \pi_{pq}\) is negative
typically will induce a decrease in price as was shown in section 4.1.3. However, because
the monopolist is beginning at \(P^R\), which is below its profit maximizing price selection
\((P^{aR})\) with quality regulation, any increase in quality will simply lower the monopolist’s
profits and price remains at \(P^R\). Since increasing price and decreasing quality, while profit
maximizing, is not feasible, this implies that point \(\Lambda\) is the feasible profit maximizing
selection given the regulatory constraints. Both the price and quality constraints are
binding. The monopolist’s profits are lower than the unregulated environment or the
environment with either price or quality regulation alone. This is represented by the lower
isoprofit level curve at the vector \((P^R,q^R)\) than at the vectors \((P^M,q^M)\), \((P^R,q^{PR})\), or \((P^{aR},q^p)\).

The analysis in this section shows that both price and quality regulation will be
binding under the assumption of the public interest theory of regulation. Price will be
lower than the unregulated level and quality will be higher than the unregulated level. As
a result, the monopolist’s profits will also be lower than the unregulated level. Since \( \pi_{q_1} = \pi_{r_q} \) is most likely positive for the local telephone industry, it is rational for state public utility commissions to impose both price and quality regulation together. Price regulation alone should result in quality levels below the unregulated position, which as discussed above are inefficiently low. Quality regulation alone should result in price levels above the unregulated position, which are also inefficiently high. This analysis provides a theoretical justification for the imposition of quality regulation combined with price regulation.

4.1.6. Monopoly with Rate-of-Return Regulation

As recently as the early 1990’s, rate-of-return regulation was the most prevalent form of economic regulation in the local telephone environment. State public utility commissions impose rate-of-return regulation for the same reason as price regulation, as a response to efficiency and equity concerns regarding a monopolist’s price incentives. While rate-of-return regulation is generally being replaced by price regulation,\(^{98}\) some state public utility commissions continue to impose rate-of-return regulation, especially for smaller local telephone companies.\(^{99}\) Thus, it is important to understand how this form of regulation will influence the monopolist’s quality decision.

\(^{98}\) The efficiency effects of rate-of-return regulation have been the subject of much research in the literature. The most well known distortion arising from rate-of-return regulation is the capital input bias formalized by Averch and Johnson (1962).

\(^{99}\) While a local telephone company may be small, it will still generally be a monopolist in its service territory.
The monopolist subject to rate-of-return regulation will solve the following objective function.

$$\max_{P,q} \pi(P,q) = PX(P,q) - C[X(P,q),q] \quad \text{s.t.} \quad \pi(P,q)/K \leq S$$  \hspace{1cm} (4.13)

where $K = K[X(P,q), q]$

Two additional variables are added in this environment. The level of capital ($K$) is assumed to be an increasing function of quantity and quality (i.e., $K_x > 0$ and $K_q > 0$). Namely, a larger amount of output, at a given level of quality, or a higher level of quality, at a given amount of output, requires additional capital. Because output is a function of price and quality, capital is also indirectly a function of price. Combining the level of capital $K$ and profit $\pi(P,q)$, $\pi(P,q)/K$ is the rate-of-return on capital. The allowed rate-of-return set by the state public utility commission is $S$. The objective function assumes that the monopolist maximizes profit with its selection of price and quality, subject to the constraint that the rate-of-return on capital does not exceed the allowed rate-of-return.

To determine whether a monopolist will provide higher or lower quality under rate-of-return regulation than the unregulated environment, I examine how the regulation influences the monopolist's first order conditions. The imposition of rate-of-return regulation will shift the monopolist's first order condition equations. The net influence of regulation on both $\pi_P$ and $\pi_q$ will determine whether the monopolist is induced to increase or decrease quality from the unregulated level.
First, I consider the impact of rate-of-return regulation on the equation $\pi_p = 0$. Figure 4.13 illustrates the profit function and rate-of-return constraint with price.

![Diagram showing profit function and rate-of-return constraint]

Figure 4.13: Monopolist profit function and rate-of-return constraint with price.

The profit function is assumed to be a concave function of price. For a given quality level $q$, the unregulated monopolist will select price $P^M$, the point where $\pi_p = 0$. This price maximizes profits and is the same outcome as shown in section 4.1.2. The rate-of-return constraint is a decreasing function of price $P$. The following logic will clarify this relationship. For a given quality level $q$, a lower price induces a greater quantity demand because $X_p < 0$. Because additional demand requires additional capital (i.e., $K_x > 0$), the increased demand requires the monopolist to employ more capital. Thus, with the rate-of-
return constraint, the monopolist is permitted to earn more aggregate profit with a lower price.\textsuperscript{100} However, the aggregate profit level permitted under rate-of-return regulation will always be no greater than the unregulated profit level. Otherwise, the unregulated monopolist would have selected the price - quality level consistent with rate-of-return regulation initially. Also, note that at $P^M$, the regulated profit level is below the unregulated level (i.e., the allowed rate-of-return is below the unregulated profit level). This is consistent with the public interest theory of regulation. These results imply that $\pi_p = 0$ shifts down with rate-of-return regulation.

\textsuperscript{100} To see this, it is important to recall that the rate-of-return constraint is $\pi/K \leq S$. If capital ($K$) increases because of an increase in demand caused by lower prices while the allowed rate-of-return ($S$) remains constant, allowed profit ($\pi$) can increase.
Next, I consider the impact of rate-of-return regulation on the equation $\pi_q = 0$.

Figure 4.14 illustrates the profit function and rate-of-return constraint with quality.

![Diagram](image)

**Figure 4.14**: Monopolist profit function and rate-of-return constraint and quality.

The profit function is portrayed as a concave function in quality. For a given price level $P$, the unregulated monopolist will select quality $q^M$, the point where $\pi_q = 0$. This is the quality level that maximizes profits. The rate-of-return constraint is an increasing function of quality $q$. The following logic applies to this constraint. For a given price level $P$, a higher level of quality induces a greater quantity demand because $X_q > 0$. Because additional demand requires additional capital (i.e., $K_q > 0$), the increased demand requires the monopolist to employ more capital. Also, higher quality, independent of the change in quantity, implies a need for additional capital (i.e., $K_q > 0$). Thus, with the rate-of-return
constraint, the monopolist is permitted to earn more aggregate profit with a higher level of quality. However, the total profit level under rate-of-return regulation is lower than the unregulated level. Otherwise, the unregulated monopolist would have selected the price-quality level consistent with rate-of-return regulation initially. Also, note that at $q^M$, the regulated profit level is below the unregulated level (i.e., the allowed rate-of-return is below the unregulated profit level). This is consistent with the public interest theory of regulation. These results imply that $\pi_q = 0$ shifts right with rate-of-return regulation.

The first scenario to consider is where $\pi_{qP} = \pi_{qQ}$ is positive. Figure 4.15 illustrates the unregulated monopolist's first order condition equations ($\pi_P$ and $\pi_q$) and the influence of rate-of-return regulation ($\pi_P'$ and $\pi_q'$) on these equations.

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101 Again, the rate-of-return constraint is $\pi/K \leq S$. If capital ($K$) increases because of an increase in demand caused by improved quality while the allowed rate-of-return ($S$) remains constant, allowed profit ($\pi$) can increase.
Figure 4.15: Monopolist with rate-of-return regulation where $\pi_{q} = \pi_{p}$ is positive.

As figure 4.15 illustrates, no definitive conclusion can be drawn regarding the impact of rate-of-return regulation on the monopolist's quality decision when $\pi_{q} = \pi_{p}$ is positive.\textsuperscript{102}

If $\pi_{q}$ shifts relatively more than $\pi_{p}$, then the monopolist will provide higher quality under rate-of-return regulation than the unregulated level. However, if $\pi_{p}$ shifts relatively more than $\pi_{q}$, then the monopolist will provide a lower level of quality under rate-of-return regulation than the unregulated level. The only option that can be excluded from consideration is where the monopolist provides lower quality and a higher price. When

\textsuperscript{102} In figure 4.15, I have illustrated a scenario where quality is higher and price is lower with rate-of-return regulation compared to the unregulated monopolist position.
\( \pi_{qP} = \pi_{Pq} \) is positive, there are offsetting effects. A lower price encourages consumption from consumers with a lower willingness to pay for quality. At the same time, inframarginal consumers are willing to pay additional for a higher quality level. The relative impact of these offsetting effects will determine whether the monopolist is induced to increase or decrease quality from the unregulated level. In the local telephone environment, the most likely scenario would appear to have \( \pi_q \) shift relatively more than \( \pi_P \) because of the inelastic demand and high subscription rates. There appears to be minimal additional demand from marginal consumers\(^{103}\) while many inframarginal consumers would pay for more quality. This suggests that quality should increase under rate-of-return regulation in the local telephone industry.

The next the scenario to consider is where \( \pi_{qP} = \pi_{Pq} \) is negative. Figure 4.16 illustrates the unregulated monopolist’s first order condition equations (\( \pi_P \) and \( \pi_q \)) and the influence of rate-of-return regulation (\( \pi_p' \) and \( \pi_q' \)) on these equations.

\(^{103}\) This is evident from the nationwide subscription rate for telephone service that exceeds 94 percent.
Figure 4.16: Monopolist with rate-of-return regulation where $\pi_{qp} = \pi_{pq}$ is negative.

As figure 4.16 illustrates, the monopolist will provide higher quality when $\pi_{qp} = \pi_{pq}$ is negative and the firm is subject to rate-of-return regulation. Under this scenario, the monopolist’s price will be lower and quality will be higher under rate-of-return regulation than the unregulated environment. Unlike the scenario when $\pi_{qp} = \pi_{pq}$ is positive, in this instance both influences move in the same direction. A lower price attracts consumers with a higher willingness to pay for quality. With a higher quality level, no consumers are willing to pay less than the current price. Thus, the price and quality effect are both positive and induce the monopolist to supply a higher quality level.
In this section, I examine a monopolist's quality with rate-of-return regulation. The outcome is uncertain. When \( \pi_{qp} = \pi_{pq} \) is positive, the outcome is unclear. The monopolist could be induced to either increase or decrease quality. When \( \pi_{qp} = \pi_{pq} \) is negative, the monopolist will increase quality. However, in the local telephone industry, the most likely outcome under rate-of-return regulation appears to be an increase in quality relative to the unregulated monopolist.

4.1.7. Summary of Monopoly, Quality, and Regulation

The preceding analysis indicates that regulation will directly influence a monopolist's quality selection. In this summary, I will only consider the scenario where \( \pi_{qp} = \pi_{pq} \) is positive, as this is consistent with the local telephone industry. Table 4.2 reports the effect that regulation, consistent with the public interest theory of regulation, will have on a monopolist's quality selection from the unregulated monopolist position. In three instances, regulation is associated with improved quality. This is important, since Spence (1975) and Sheshinski (1976) find that an unregulated monopolist facing conditions similar to the local telephone industry will generally supply an inefficiently low level of quality. However, price regulation is associated with lower quality. This is also important, since many state public utility commissions are adopting price cap or rate freeze regulation. The results in table 4.2 suggest that regulators should combine price regulation with quality regulation if the goal is to maintain or improve quality.
<table>
<thead>
<tr>
<th>Type of Regulation</th>
<th>Quality</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Regulation</td>
<td>Improve</td>
<td>Increase</td>
</tr>
<tr>
<td>Price Regulation</td>
<td>Lower</td>
<td>Lower</td>
</tr>
<tr>
<td>Price and Quality Regulation</td>
<td>Improve</td>
<td>Lower</td>
</tr>
<tr>
<td>Rate-of-Return Regulation</td>
<td>Improve</td>
<td>Lower</td>
</tr>
</tbody>
</table>

Table 4.2: Impact of regulation on quality and price in a monopoly environment.

4.2. The Dominant Firm - Competitive Fringe, Quality, and Regulation Environment

In this section, I examine the relationship between the dominant firm - competitive fringe market structure, quality, and regulation. Minimal literature exists that addresses quality in market structures between monopoly and competition. The literature that does exist generally focuses on duopoly and oligopoly market structures. The dominant firm - competitive fringe model considers an environment with a single large firm and a group of small firms. While the dominant firm establishes the price for the market, the presence of the competitive fringe results in prices below monopoly levels. I examine a dominant firm's quality selection in the dominant firm - competitive fringe environment. From the unregulated monopoly position, the presence of the competitive fringe can

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104 In section 4.1.1, I discuss the literature that addresses quality in a monopoly environment. Abbott (1955) is the first to examine quality, with the primary objective to develop a theory of quality determination in competitive markets.
induce the dominant firm to either improve or lower its quality. Furthermore, regulation imposed in the monopoly environment may or may not influence the dominant firm’s quality selection in the dominant firm - competitive fringe environment.

4.2.1. Literature Review

A natural extension of the literature addressing monopoly, quality, and regulation is the introduction of competition. In general, this literature focuses on duopoly and oligopoly market structures. Vander Weide and Zalkind (1981) and Shaked and Sutton (1982) consider a firm that offers a single level of quality to all consumers. Vander Weide and Zalkind examine quality in an oligopoly environment while Shaked and Sutton examine quality in a duopoly environment. Cook (1993) considers a firm that offers a range of quality choices to consumers in a dominant firm - competitive fringe environment. In general, these authors find inconclusive evidence regarding the impact of competition on quality. Importantly, no work addresses a firm that offers a single level of quality to all consumers in a dominant firm - competitive fringe environment. As was mentioned previously, this scenario most closely matches the local telephone industry and other public utility industries.

Vander Weide and Zalkind (1981) provides an early analysis of the impact of competition on the quality offered by firms. The authors’ primary interest is the impact that entry and price deregulation has on the quality that firms offer, where the firm offers a single level of quality to all consumers. To conduct their analysis, the authors employ a
model of oligopolistic price-quality rivalry. There are three important assumptions in the authors’ model: (1) the firms engage in Cournot-Nash competition, (2) the firms are identical, and (3) there are specific forms for the market demand and cost functions.

Regarding the cost functions, the authors consider one scenario where quantity and quality are independent and a second scenario where quantity and quality are interdependent. The firm’s objective function is the maximization of profits. Because the authors assume Cournot-Nash competition and identical firms, all competitors will adopt the same strategy and will not alter their strategy based on the firm’s quality selection. To determine the impact that competition has on the firm’s quality selection, the authors perform comparative statics with implicit differentiation of the first order conditions. The first scenario considers deregulated entry, price cap regulation, and quantity and quality independent in the cost function. Vander Weide and Zalkind show that with an increasing number of firms, the firm will lower its quality offering (i.e., entry is associated with lower firm quality). To examine both entry and price deregulation, the authors use total differentials. They find that the impact on the firm’s quality is indeterminate. The next scenario considers deregulated entry, price cap regulation, and quantity and quality interdependent in the cost function. Vander Weide and Zalkind show that with an increasing number of firms, the firm will improve its quality offering (i.e., entry is associated with improved firm quality). In general, Vander Weide and Zalkind conclude that the “economic consequences of deregulation depend on a variety of factors” including the variables that were previously regulated, the variables that are deregulated, and the
form of the demand and cost function.\textsuperscript{105} While the authors' analysis is insightful, it does not address the dominant firm - competitive fringe environment prevalent in the local telephone and other public utility industries.

Shaked and Sutton (1982) employ a game theoretic approach to examine the relationship between competition and quality. The authors employ a three stage sequential game and solve for the perfect equilibrium.\textsuperscript{106} In the third-stage, Bertrand price competition occurs. The authors make three assumptions in the third stage: (1) consumers have identical tastes but a continuum of incomes, (2) income is uniformly distributed, and (3) utility assumes a specific, multiplicative form. Given the assumptions and Bertrand price competition, the authors determine that only two firms will be present in the market. The price competition between the “higher quality” products drives the prices to levels at which consumers do not purchase “lower quality” products.\textsuperscript{107} In the second stage, the firms make their quality selections. Each firm offers a single level of quality to all consumers. The authors begin with the firms’ revenue functions, which depend on the firm’s own quality choice and the quality choice of the competitor. The authors derive two properties from the revenue function: (1) the firm with the “high quality” product will have greater revenue and (2) revenues for both firms increase as the quality of the “high

\textsuperscript{105} Vander Weide and Zalkind (1981): 144.

\textsuperscript{106} A perfect equilibrium occurs when a Nash equilibrium occurs in every subgame of the multiple stage game. To solve for the perfect equilibrium, a process of backward induction is used where the analysis begins with the final stage of the game and works backward to the first stage of the game. Gardner (1995), 147-172.

\textsuperscript{107} This is a result of the intense price competition associated with Bertrand competition.
quality” product improves. As a result of these properties and the Bertrand price competition, the two firms will supply products with different quality levels and both will earn positive profits. Finally, in the first stage, the firms make their entry decisions. Based on the analysis of the following stages, only two firms will enter the market. Shaked and Sutton provide interesting insights on the entry process and quality decision. Thus, their analysis provides important theoretical information regarding product differentiation in duopoly and oligopoly markets. Intense Bertrand price competition induces firms to provide differentiated products and entry will be limited. However, the analysis is not applicable for markets, such as the local telephone industry and other public utility industries, where decisions are not made simultaneously by all firms and where one firm might be in a dominant position because of its scale, scope, or former monopoly position.

Cook (1993) examines the impact of a competitive fringe when a monopolist, which becomes a dominant firm with entry, offers a range of quality options to consumers. Cook’s analysis builds on the previous work of Mussa and Rosen (1978) who find, as was mentioned in section 4.1.1, that a monopolist will distort the quality selection by providing inefficiently poor quality to all consumers except those with the highest demand for quality. In Cook’s analysis, the monopolist, or dominant firm, possesses superior technology over a given range of quality levels and the competitive fringe supply output at the market price. Cook considers three scenarios for the competitive fringe supply. The competitive fringe can supply a low quality substitute, a high quality substitute, or both a low and high quality substitute. The analytical approach Cook employs is consistent with Mussa and Rosen. In the low quality substitute scenario, Cook shows that the dominant
firm will continue to distort quality for consumers with a low demand for quality. However, aggregate welfare improves because the dominant firm’s price declines and some consumers with low demand for quality purchase the substitute product. In the high quality substitution scenario, Cook shows that all consumers except for those with the lowest demand for quality are served by an inefficiently high level of quality. Thus, the distortion that Mussa and Rosen found is reversed with a high quality substitute. Finally, where both low and high quality substitutes are available, the dominant firm’s quality is biased downward for consumers with a low demand for quality and biased upward for consumers with a high demand for quality. Even with these biases however, there is a welfare improvement versus the Mussa and Rosen outcome because the bias is reduced somewhat for all consumers. In general, Cook’s analysis shows that the presence of a competitive fringe supplying substitute products will improve aggregate welfare. In addition, welfare is shifted from monopoly profit to consumer surplus. However, Cook’s analysis is not applicable to industries such as the local telephone or other public utilities where the firm offers a single level of quality to all consumers.

4.2.2. Dominant Firm - Competitive Fringe Model

The dominant firm - competitive fringe model explains the dominant firm environment, as contrasted with the monopoly, oligopoly, or perfectly competitive environments. The dominant firm environment is a market with a single large firm and a group of small firms, the competitive fringe. In actuality, there are two models that
explain the dominant firm environment (White 1981). One model is the limit price model. In the limit price model, the dominant firm establishes a price such that the competitive fringe either do not enter the market or, if they have already entered the market, they do not expand. The other model is the dominant firm - competitive fringe model, also referred to as the price leadership model. Schenzler, Siegfried, and Thweatt (1992) trace the history of the dominant firm - competitive fringe model. The dominant firm - competitive fringe model was introduced by Forchheimer (1908). Stigler (1940) later formalized the model. The dominant firm - competitive fringe model fell somewhat out of favor in the early 1980’s as researchers shifted towards the more game theoretic limit price model (Cherry 2000). However, the dominant firm - competitive fringe model has experienced a resurgence in recent years. This resurgence is especially true for researchers examining the telecommunications industry and other public utility industries where formerly regulated monopoly markets are being opened to competition.^[108]

Before examining the strategies and model in depth, I will discuss several important preliminaries. As the name implies, there are two categories of firms in the dominant firm - competitive fringe model. The dominant firm is considerably larger than any individual firm that comprises part of the competitive fringe. In a cross-section empirical analysis of 124 industries, White (1981) found that market dominance implies a market share greater than 50 percent. Thus, dominant firms comprise a significant component of the industries where they operate. The competitive fringe consists of firms

^[108] For recent examples of the dominant firm - competitive fringe model applied to the telecommunications industry, see Blank, Kaserman, and Mayo (1998) and Abel (1999).
smaller in scale. However, the competitive fringe collectively could control a sizable portion of the industry (Carlton and Perloff 1994), up to 50 percent of the market based on White’s analysis. Several factors can be responsible for the presence of the dominant firm. First, the dominant firm may possess a cost advantage. This cost advantage can be the result of a first mover advantage, where the dominant firm is able without the challenges posed by competition to acquire optimal economies of scale and become more productive through learning-by-doing. Second, the dominant firm may produce a superior product. Finally, the dominant firm may benefit from consumer inertia. Consumer inertia is especially true in the public utility industries where some consumers are disinclined to switch away from the former monopoly, even if a superior price-quality service option is available from a competitor.\(^{109}\) Consumer inertia is another advantage arising from the dominant firm’s first mover status. Finally, there are two important assumptions regarding the dominant firm’s behavior and knowledge. First, entry is assumed to have occurred and the dominant firm takes no direct action to deter entry. Second, the dominant firm has accurate information about the market demand function and the competitive fringe firms’ cost functions.

The strategies of the dominant firm and the competitive fringe are interdependent (Rosenberg and Clements 2000). Because the dominant firm possesses information about the competitive fringe firms’ cost functions, it can anticipate the aggregate competitive

\(^{109}\) In a study of 22 natural gas customer choice programs in 13 states, Costello (1999) found that “most small gas customers are reluctant to relinquish bundled sales service provided by their local gas utility even when alternative service would result in bill savings.” Costello (1999), iii.
fringe supply\(^{110}\) at different prices. With information about aggregate competitive fringe supply and the market demand, the dominant firm will choose a price that best satisfies its assumed goal, namely to maximize profits. However, the dominant firm will maximize profits over residual demand, or the market demand less aggregate competitive fringe supply, versus the market demand as a monopolist. Alternatively, the competitive fringe firms’ strategy involves price taking behavior. Because each competitive fringe firm is small, each assumes that it cannot individually influence the market price. Thus, competitive fringe firms simply follow the dominant firm’s price leadership. If the products or services are homogeneous, the competitive fringe firms will sell at the same price as the dominant firm. If the products or service are differentiated, the competitive fringe firms will sell at the dominant firm’s price plus or minus some differential (Scherer 1980).

To begin, I consider the static dominant firm - competitive fringe model with a homogeneous product or service. Figure 4.17 illustrates the static model. The left panel illustrates the competitive fringe and the right panel illustrates the dominant firm. Consistent with the discussion of a monopolist in section 4.1, \(X(P)\) defines the market demand function. \(MC^f\) is a competitive fringe firm’s marginal cost function.\(^{111}\) \(S^f(P)\) is the competitive fringe aggregate supply, which is simply the horizontal summation of \(MC^f\). \(X^R(P)\) is the dominant firm’s residual demand function. The residual demand function

\(^{110}\) Aggregate competitive fringe supply is the horizontal summation of the individual competitive fringe firms’ supply.

\(^{111}\) In figure 4.17, all competitive fringe firms are assumed to have identical cost functions. This assumption does not influence the analysis and is employed to simplify the figure.
Figure 4.17: Static dominant firm - competitive model.
$X^R(P)$ is simply the market demand function $X(P)$ less the competitive fringe supply $S^f(P)$ at each price. $MC^d$ is the dominant firm’s marginal cost function. In this instance, the dominant firm’s marginal cost function is placed lower and with a flatter slope than the competitive fringe firm’s marginal cost function. This indicates that the dominant firm possesses a cost advantage compared to the typical competitive fringe firm.\footnote{As mentioned previously, the dominant firm could possess other advantages vis-à-vis the competitive fringe besides a cost advantage.} Finally, $MR^R$ is the dominant firm’s residual marginal revenue function, based on the residual demand function $X^R(P)$, and $MR$ is the dominant firm’s marginal revenue function, based on the market demand function $X(P)$.

To begin, I consider the competitive fringe portion of the dominant firm - competitive fringe model in figure 4.17. As was mentioned previously, the competitive fringe sell at the price the dominant firm establishes, or the competitive fringe firms follow the dominant firm’s price leadership. When the dominant firm establishes a price below $P^L$, the competitive fringe will supply nothing. This outcome occurs because any price below $P^L$ is also below the representative competitive fringe firm’s marginal cost function. A profit maximizing firm will not supply units at a price below marginal cost because it will loose money on each unit sold. At price $P^U$, the competitive fringe firms supply the entire market demand. This is represented by the intersection of the competitive fringe aggregate supply $S^f(P)$ and the market demand $X(P)$. Finally, at price $P^*$, the dominant firm’s price, each competitive fringe firm will supply $x^f$ and aggregate competitive fringe supply is $X^f$. This outcome occurs because profit maximization in a competitive market,
which the competitive fringe portion of the dominant firm - competitive fringe model assumes, implies that each firm supplies a quantity of the product or service where its marginal cost, at that quantity, equals the market price.

Next, I consider the dominant firm portion of the dominant firm - competitive fringe model in figure 4.17. As was mentioned above, at prices below $P^L$, the competitive fringe supply nothing. Thus, for all prices below $P^L$, the dominant firm's residual demand function $X^R(P)$ is simply the market demand function $X(P)$, since $S^f(P)$ is zero. Also as mentioned above, at prices above $P^U$, the dominant firm's residual demand is zero because the competitive fringe supply the entire market demand. For prices between $P^L$ and $P^U$, the dominant firm's residual demand function $X^R(P)$ lies below the market demand function $X(P)$, representing the constraint placed on the dominant firm by the competitive fringe supply. The dominant firm behaves in a manner consistent with the monopolist discussed in section 4.1. However, the dominant firm maximizes profits by equating its marginal cost $MC^d$ with its residual marginal revenue function $MR^R$ versus the marginal revenue function $MR$ based on the market demand function $X(P)$, as in the monopoly model. In addition, the dominant firm establishes its price based on the residual demand function $X^R(P)$. In figure 4.17, the dominant firm will supply quantity $x^d$ of the product or service at price $P^*$. At price $P^*$, total market demand is $X^*$. The difference between the dominant firm's supply $x^d$ and the market demand $X^*$ is supplied by the competitive fringe $X^c$. 

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The presence of competitive fringe profits creates a dynamic element in the dominant firm - competitive fringe model (Scherer 1980 and Cherry 2000). If competitive fringe firms are earning positive economic profits at the dominant firm’s price, existing competitive fringe firms will expand or new competitive fringe firms will enter, or both could occur. This will increase the aggregate competitive fringe supply, implying that $S^f(P)$ will shift right and possibly down in figure 4.17. As the aggregate competitive fringe supply increases, the dominant firm’s residual demand function declines further from the market demand function, or $X^R(P)$ will become flatter and possibly shift down in figure 4.17. The outcome is a lower market price and an increased share of the product or service supplied by the competitive fringe. The expansion of existing competitive fringe firms or the entry of new competitive fringe firms will continue until competitive fringe profits are dissipated. If the dominant firm’s advantages (e.g., cost, consumer inertia) are eliminated, the dominant firm’s position will completely erode and the market will become perfectly competitive. According to Cherry (2000), this dynamic element of the dominant firm - competitive fringe model provides a theoretical link to the limit price model. In both instances, the outcome is similar. The dominant firm establishes a price such that existing competitive fringe firms will not expand and additional competitive fringe firms will not enter. However, the motivation for the outcome is different in the two models. In the limit price model, the dominant firm actively establishes a price such that competitive fringe expansion or entry does not occur. In the dominant firm - competitive fringe model, the dominant firm’s price is influenced by the competitive fringe itself.
The final element to consider is the impact of quality on the dominant firm - competitive fringe model. The basic dominant firm - competitive fringe model discussed above and illustrated in figure 4.17 does not incorporate quality. In section 4.1, market demand is assumed to be a function of price and quality, or \( X = X(P,q) \). If there is a single level of quality provided by all firms in the market, the basic model changes very little. The market demand function will either shift to the right if the level of quality improves or shift to the left if the level of quality declines, because \( X_q > 0 \). The shift in market demand will influence the dominant firm’s price, the competitive fringe and dominant firm supply, and total demand. However, it does not influence the respective firms’ strategies, the firms’ relative positions in the market, or the dynamic nature of the model. The market simply becomes larger, with improved quality, or smaller, with lower quality. Differences will arise when the competitive fringe and dominant firm offer different levels of quality. I discuss this scenario in the following two sections.

4.2.3. Unregulated Dominant Firm - Competitive Fringe with Quality

To begin the analysis of quality in a dominant firm - competitive fringe environment, I consider where in price - quality space a competitive fringe firm will plausibly place its product or service and what consumers will switch to the competitive fringe firm. The framework proposed by Mussa and Rosen (1978) provides a mechanism for this analysis. Consumers have the following utility function: \( U = \theta q - P \), where \( U \) is total utility, \( P \) is price, and \( \theta \) is the consumer’s willingness to pay for quality. Figure 4.18
provides an example with three current consumers of the dominant firm's product or service which is placed at \((P^{DF}, Q^{DF})\) in price-quality space. One consumer has high demand for quality \((\theta^H)\), one consumer has low demand for quality \((\theta^L)\), and one consumer has median demand for quality \((\theta^M)\). The lines \(\theta^H\), \(\theta^L\), and \(\theta^M\) are isoutility lines. Isoutility lines identify all points in price-quality space where the consumer's utility is the same. Thus, the consumer would be indifferent between all combinations of price and quality located on the isoutility line. Consumers with a higher willingness to pay for quality have isoutility lines with steeper slopes. This illustrates that the consumer will pay a higher price at every quality level than consumers with a lower willingness to pay for quality. If the isoutility line passes through the origin, the consumer's utility is zero. Isoutility lines crossing the vertical axis below the origin signify positive utility. Isoutility lines crossing the vertical axis above the origin signify negative utility.
There are seven plausible locations in price-quality space where a competitive fringe firm could place its product or service. These locations are identified by the letters A through G in figure 4.18. Locations A, B, and C identify placements with a lower price and lower quality than the dominant firm. Locations E, F, and G identify placements with a higher price and higher quality than the dominant firm. Finally, location D identifies a placement with a lower price and higher quality than the dominant firm. The dominant firm’s placement \((P^{DF}, q^{DF})\) strictly dominates any other location in price-quality space. This occurs because consumers’ utility declines with a movement up and left and no
consumer will switch to a competitive fringe product or service if their utility decreases. Thus, all other locations are not plausible for a competitive fringe firm to place its product or service. Alternatively, location D strictly dominates the dominant firm’s placement \((P^{DF}, q^{DF})\). At location D, a competitive fringe firm provides consumers with a lower price and higher quality product or service. Thus, consumers’ utility will increase. Table 4.3 identifies which current consumers will switch to a competitive fringe firm at each location and also identifies possible new consumers. Locations A and G are niche strategies for a competitive fringe firm. At location A, a competitive fringe firm will attract from the dominant firm consumers with a low willingness to pay for quality as well as some individuals not currently consuming. At location G, a competitive fringe firm will attract the median to high willingness to pay consumers from the dominant firm. Locations C, D, and E are broad-based strategies that could attract a wide range of consumers, both from the dominant firm and individuals not currently consuming.
<table>
<thead>
<tr>
<th>Location</th>
<th>Consumers Attracted to the Competitive Fringe</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$\theta^L$ to $\theta^M$ dominant firm consumers and some individuals with lower willingness to pay not currently consuming</td>
</tr>
<tr>
<td>B</td>
<td>$\theta^L$ to $\theta^H$ dominant firm consumers and some individuals with lower willingness to pay not currently consuming</td>
</tr>
<tr>
<td>C</td>
<td>All dominant firm consumers and some individuals with lower willingness to pay not currently consuming</td>
</tr>
<tr>
<td>D</td>
<td>All dominant firm consumers and some individuals with lower willingness to pay not currently consuming</td>
</tr>
<tr>
<td>E</td>
<td>All dominant firm consumers and some individuals with lower willingness to pay not currently consuming</td>
</tr>
<tr>
<td>F</td>
<td>$\theta^L$ to $\theta^H$ dominant firm consumers</td>
</tr>
<tr>
<td>G</td>
<td>$\theta^M$ to $\theta^H$ dominant firm consumers</td>
</tr>
</tbody>
</table>

Table 4.3: Consumers attracted to the competitive fringe at various price-quality placement locations.

There are two important issues arising from the price-quality placement locations for the competitive fringe. First, in the dominant firm-competitive fringe model, the dominant firm possesses competitive advantages (e.g., consumer inertia). Without these competitive advantages, any competitive fringe price-quality placement that increases the consumer's utility by some trivial amount will cause the consumer to switch to the competitive fringe. With the competitive advantages, such as consumer inertia, the competitive fringe will likely need to offer the consumer a non-trivial improvement in the
consumer's utility before the consumer will switch to the competitive fringe. Thus, the lines identifying when consumers will switch and will not switch are not as distinct as figure 4.18 indicates. Second, competitive fringe firms could compete with the dominant firm with low quality substitutes or high quality substitutes. In addition, since there could be many competitive fringe firms, the dominant firm could also face competition from both low quality and high quality substitutes simultaneously.

In the following analysis, there is a sequence of activities. To begin, the dominant firm, the erstwhile monopolist, is assumed to be in the market with a product or service placed in price-quality space. With a dominant firm or monopolist well established in the market, the competitive fringe firm or firms enter. The competitive fringe firm or firms place their products or services in price-quality space. Finally, the dominant firm will consider altering the placement of its product or service in price-quality space in response to the competitive fringe entry. However, if the dominant firm could anticipate the competitive fringe product or service placement in price-quality space, the dominant firm could modify its placement before the competitive fringe entry. While this would represent a change in the sequence of events, it does not alter the major hypothesis. Namely, the dominant firm will generally change the placement of its product or service in price-quality space during the transition from a monopoly environment to a dominant firm-competitive fringe environment.

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113 This is consistent with the results in Costello (1999).
As a monopolist, the firm serves a range of consumers with different willingness to pay for quality. Figure 4.19 incorporates the concepts from figure 4.18 to illustrate the range of consumers. The firm serves consumers from $\theta^L$, with the lowest willingness to pay, to $\theta^H$, with the highest willingness to pay. I assume that there are no consumers beyond $\theta^H$ (i.e., the consumer represented by $\theta^H$ possesses the highest willingness to pay for the specific product or service). However, I do assume that there are individuals below $\theta^L$ (i.e., there are individuals with lower willingness to pay who do not consume the product or service in the current price-quality placement). These assumptions are consistent with the framework in figure 4.18, where higher willingness to pay is represented by a steeper isouitility function and utility increases as price decreases and quality increases. Figure 4.19 is drawn with a uniform distribution. However, a different distribution (e.g., normal distribution) would not significantly alter the analysis.

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Figure 4.19: Distribution of consumers by willingness to pay.
To begin the analysis, I consider the differences in the objective function and first order conditions for the monopolist environment discussed in section 4.1 and the dominant firm - competitive fringe environment. For convenience, I will repeat the monopolist's objective function.\textsuperscript{114}

\[
\max_{P,q} \pi^M(P, q) = PX(P, q) - C[X(P, q), q] \quad (4.14)
\]

As was shown in section 4.1, the monopolist solves two first order conditions, one with respect to price and one with respect to quality. These first order conditions are repeated below.

\[
\pi^M_P = X(P, q) + PX_P(P, q) - C_XX_P(P, q) = 0 \quad (4.15)
\]

\[
\pi^M_q = PX_q(P, q) - C_XX_q(P, q) - C_q(X, q) = 0 \quad (4.16)
\]

It is important to note that the objective function and first order conditions contain the market demand function and its derivative with respect to price in equation 4.15 and

\textsuperscript{114} The superscript $^M$ is used to denote monopoly. Below, the superscript $^{DF}$ is used to denote dominant firm.
quality in equation 4.16. With the dominant firm - competitive fringe model, the objective function changes slightly, with the residual demand function replacing the market demand function. The dominant firm’s objective function is below.

\[
\max_{P,q} \pi^{DF}(P,q) = PX^R(P,q) - C[X^R(P,q),q]
\] (4.17)

Similar to the monopolist, the dominant firm solves two first order conditions.

\[
\pi^{DF}_P = X^R(P,q) + PX^R_P(P,q) - C_X X^R_P(P,q) = 0
\] (4.18)

\[
\pi^{DF}_q = PX^R_q(P,q) - C_X X^R_q(P,q) - C_q(X,q) = 0
\] (4.19)

Since the objective function contains the residual demand function, the two first order conditions with respect to price in equation 4.18 and quality in equation 4.19 also contain the residual demand function as opposed to the market demand function.

Two factors will determine what impact the presence of the competitive fringe has on the dominant firm’s quality selection. The first factor is the placement in price - quality space of the competitive fringe products or services. The competitive fringe products or services can be either low quality substitutes, high quality substitutes, or both simultaneously. I consider these three scenarios below. The second factor is the shift in the first order conditions from the monopoly environment to the dominant firm -
competitive fringe environment. The first order condition with respect to price ($\pi_{DF_p} = 0$) will shift down in all instances (i.e., $\pi_{DF_p} = 0$ lies below $\pi^M_p = 0$ in price - quality space).

To motivate this conclusion, I will consider a scenario where the dominant firm, as a former monopolist, selects a price - quality placement and cannot change the quality and the competitive fringe must also offer the same level of quality. How will the entry of the competitive fringe shift $\pi_p = 0$? Figure 4.20 will illustrate the change.\(^{115}\) According to the dominant firm - competitive fringe model (e.g., figure 4.17), the presence of the competitive fringe will cause the dominant firm's profit maximizing price to decline. Thus, $\pi_p = 0$ must shift down to indicate that the profit maximizing response to the competitive fringe supply, holding quality constant, is to reduce price. There is also an intuitive explanation for the price reduction. In the dominant firm - competitive fringe environment, the dominant firm now encounters a residual demand function that is lower and more elastic than the market demand function that it encountered when the firm was a monopolist. This is seen in figure 4.17 as the difference between $X(P)$ and $X^R(P)$. The result is that $X^R_{DF}(P,q)$ must be lower than $X_P(P,q)$. This implies that $\pi_p = 0$ will decrease. Thus, the critical factors in determining the dominant firm's quality versus the monopolist's quality is the price - quality placement of the competitive fringe and the movement of $\pi_q = 0$. These two factors are interrelated.

\(^{115}\) The first order condition with respect to quality ($\pi_q = 0$) is excluded because quality cannot change in the scenario.
Figure 4.20: Shift in $\pi_p = 0$ induced by the entry of the competitive fringe.

The first scenario that I will consider is the competitive fringe offering a low quality substitute.\textsuperscript{116} Figure 4.21 illustrates the distribution of consumers between the dominant firm and the competitive fringe where the competitive fringe offer a low quality substitute.

\textsuperscript{116} In this section, I only consider the scenario where $\pi_{qp} = \pi_{pq}$ is positive, as is consistent with the local telephone industry. The same type of analysis would follow where $\pi_{qp} = \pi_{pq}$ is negative.
Figure 4.21: Distribution of consumers between the dominant firm and the competitive fringe when the competitive fringe offer a low quality substitute.

The dominant firm - competitive fringe model assumes that the competitive fringe will supply a faction of the market demand. With the competitive fringe offering a low quality substitute, the competitive fringe will serve the faction of consumers with the lowest willingness to pay for quality. The consumers served by the competitive fringe ($X^f$) extend from $\theta^*$ down through $\theta^L$, the lowest individual currently consuming the dominant firm’s product or service, and could include individuals with a lower willingness to pay not currently consuming.\(^{117}\) The consumers served by the dominant firm ($x_d$) extend from $\theta^*$ up to $\theta^H$. I have shown that $\pi_p = 0$ will shift down with the competitive fringe. Thus, the important factor is how the presence of a competitive fringe offering a low quality substitute will influence $\pi_q = 0$. This first order condition should shift to the right in this

\(^{117}\) The consumer identified by $\theta^*$ is indifferent between the dominant firm and competitive fringe product or service. As was mentioned previously, this could involve a consumer who would receive a substantial utility increase from switching to the competitive fringe because consumer inertia will reduce the likelihood that a consumer will switch when the difference in their utility between the dominant firm and competitive fringe is “close.”
scenario (i.e., $X^R_q$ is greater than $X_q$). This outcome occurs because the dominant firm will serve consumers that generally have a higher willingness to pay for quality than when the firm was a monopolist and served the entire spectrum of consumers from $\theta^L$ to $\theta^H$.

The low demand consumers are now served by the competitive fringe and the dominant firm retains the high demand consumers. Figure 4.22 illustrates the outcome.

![Graph showing price and quality selection with a competitive fringe providing a low quality substitute.]

Figure 4.22: The dominant firm’s price and quality selection with a competitive fringe providing a low quality substitute.
As figure 4.22 indicates, the outcome can be uncertain with quality improving or declining.\textsuperscript{118} The outcome depends on the relative shift in \( \pi_q = 0 \) and \( \pi_p = 0 \). If \( \pi_q = 0 \) shifts relatively more than \( \pi_p = 0 \), then quality will improve. If \( \pi_p = 0 \) shifts relatively more than \( \pi_q = 0 \), then quality will decline. However, we might anticipate that the dominant firm will improve quality (i.e., \( \pi_q = 0 \) will shift more than \( \pi_p = 0 \)). Again, this occurs because the dominant firm retains the consumers with the highest willingness to pay for quality. The dominant firm could improve quality and lower its price, maintain the monopoly price, or even raise its price.\textsuperscript{119} The outcome where the dominant firm improves quality is also intuitive. If the dominant firm improves quality, the dominant firm and competitive fringe will be providing more differentiated products or services. This differentiation reduces the substitutability between the dominant firm's product or service and the competitive fringe product or service. This produces more inelastic demand and therefore higher prices and profits than would occur with less differentiation.

This outcome is consistent with the basic dominant firm - competitive fringe framework. The dominant firm will increase quality and set a price in a range that bounds the former monopoly price. Also, the dominant firm's profits will be lower. In this scenario, profits must decline because if they did not, the monopolist would have initially chosen the price - quality selection that the dominant firm chose. The dominant firm -

\textsuperscript{118} In figure 4.22, I have illustrated a scenario where quality is higher in the dominant firm - competitive fringe environment than in the monopoly environment.

\textsuperscript{119} The dominant firm - competitive fringe model implies that the presence of a competitive fringe results in a lower price. However, if the dominant firm improves the quality of its product or service, consumers can experience higher utility even with a price increase.
competitive fringe model also implies that the firm's profits decline from the monopoly level with the presence of the competitive fringe. The competitive fringe will offer a lower quality product or service and taking the dominant firm's price as given, will lower its price from the dominant firm's price by some increment as suggested by Scherer (1980). Finally, aggregate demand will increase because the lower price substitute attracts individuals who were not consuming in the monopoly environment. Each of these outcomes is consistent with the basic dominant firm - competitive fringe model predictions.

The second scenario that I will consider is the competitive fringe offering a high quality substitute. Figure 4.23 illustrates the distribution of consumers between the dominant firm and the competitive fringe when the competitive fringe offer a high quality substitute.

![Figure 4.23: Distribution of consumers between the dominant firm and the competitive fringe when the competitive fringe offer a high quality substitute.](image)
In this scenario, the competitive fringe will serve the fraction of consumers with the highest willingness to pay for quality. The consumers served by the competitive fringe ($X^c$) extend from $\theta^*$ to $\theta^H$. The consumers served by the dominant firm ($x^d$) extend from $\theta^*$ down through $\theta^L$, and could include individuals with a lower willingness to pay not currently consuming. Again, $\pi_p = 0$ will shift down with the competitive fringe in the market. Because the competitive fringe now serve the consumers with the highest willingness to pay for quality, the dominant firm’s first order condition $\pi_q = 0$ should shift to the left in this scenario (i.e., $X^R_q$ is less than $X_q$). This occurs because the dominant firm will serve consumers that generally have a lower willingness to pay for quality than when the firm was a monopolist. Demand will increase less due to an increase in quality from these consumers than when the firm served the entire spectrum of consumers ($\theta^L$ to $\theta^H$) as a monopolist. Figure 4.24 illustrates the outcome.
Figure 4.24: The dominant firm’s price and quality selection with a competitive fringe providing a high quality substitute.

In this scenario, the outcome is unambiguous. The dominant firm will reduce both its price and quality. Both the downward shift of \( \pi_p = 0 \) and the leftward shift of \( \pi_q = 0 \) are associated with lower price and quality; both influence quality in the same direction. This price and quality reduction will allow the dominant firm to serve individuals who did not consume the product or service when the firm was a monopolist. Again, the outcome is also intuitive. By lowering quality with the competitive fringe supplying a high quality substitute, the dominant firm and competitive fringe will be providing more differentiated
products or services. The differentiation reduces the substitution between the dominant firm and competitive fringe products or services that otherwise would create more elastic demand and therefore lower prices and profits.

This outcome can also be explained in the basic dominant firm - competitive fringe framework. The dominant firm lowers its quality and establishes a price below the former monopoly level. Also, the dominant firm’s profit will be lower. If the firm’s profits with the new price - quality selection were not lower than the monopoly level, the firm would have selected the price - quality combination initially. This is consistent with the prediction of the dominant firm - competitive fringe model. The competitive fringe offers a high quality substitute and taking the dominant firm’s price as given, increases its price by some increment above the dominant firm’s price as Scherer (1980) suggests. Finally, aggregate demand expands as new consumers with a lower willingness to pay begin purchasing the product or service. Again, these outcomes derived from a framework of quality are consistent with the predictions from the basic dominant firm - competitive fringe model.

The third scenario that I will consider is the competitive fringe offering a low and high quality substitute. Since each firm must offer a single level of quality to all consumers, the presence of both low and high quality substitutes implies that two or more competitive fringe firms are present in the market. Figure 4.25 illustrates the distribution of consumers between the dominant firm and the competitive fringe.
Figure 4.25: Distribution of consumers between the dominant firm and the competitive fringe when the competitive fringe offer a low and high quality substitute.

In this scenario, the competitive fringe will serve the fraction of consumers with the lowest and highest willingness to pay for quality. The consumers served by the competitive fringe ($X^f$) extend from $\theta^{**}$ to $\theta^H$, those with a high willingness to pay, and from $\theta^*$ down through $\theta^L$, those with a low willingness to pay, and could include individuals with a lower willingness to pay not currently consuming. The consumers served by the dominant firm ($x^d$) extend from $\theta^*$ to $\theta^{**}$, those with moderate willingness to pay. Consistent with the previous scenarios, $\pi_D = 0$ will shift down with the competitive fringe in the market. However, the impact on $\pi_q = 0$ is unclear. The dominant firm loses consumers with both low and high willingness to pay for quality. The loss of consumers with a low willingness to pay for quality ordinarily implies that remaining consumers have a higher overall willingness to pay and therefore $\pi_q = 0$ shifts to the right. However, the loss of consumers with a high willingness to pay for quality ordinarily implies that remaining consumers have a lower overall willingness to pay and therefore $\pi_q = 0$ shifts to the left. The low quality substitutes and high quality substitutes influence the dominant firm in a divergent manner.
and could offset each other. Thus, the outcome appears driven by two factors: (1) the fraction of each group of consumers served by the competitive fringe and (2) the intensity of the willingness to pay among the remaining consumers served by the dominant firm. This implies that no firm conclusions can be made regarding the dominant firm’s quality when the competitive fringe supply both a low and high quality substitute.

This outcome is also consistent with the basic dominant firm - competitive fringe framework. While the dominant firm’s quality outcome is unclear, the dominant firm should set a price below the monopoly level. The dominant firm’s profits will also decline. If the firm’s profit with the new price - quality selection were not lower than the monopoly level, the firm would have selected the price - quality combination initially. This is consistent with the prediction of the dominant firm - competitive fringe model. Some competitive fringe firms will offer a lower quality substitute and taking the dominant firm’s price as given, lower their price by some increment while other competitive fringe firms will offer a higher quality substitute and taking the dominant firm’s price as given, increase their price by some increment (Scherer 1980). Finally, there will be more aggregate demand as new consumers with a lower willingness to pay are attracted by the new price - quality options.
4.2.4. Dominant Firm - Competitive Fringe with Quality and Regulation

In this section, I consider a dominant firm's quality selection when the firm encounters both a competitive fringe and regulation. As in section 4.1, I consider four regulatory scenarios. These scenarios are quality regulation, price regulation, price and quality regulation, and rate-of-return regulation. I also consider scenarios where the competitive fringe offers a low quality substitute and a high quality substitute. Thus, there are eight different scenarios. For each scenario, I examine the dominant firm's price-quality selection. There are several important questions for each scenario. First, how does the quality level in the dominant firm - competitive fringe environment differ from that in the monopoly environment? Second, does competition or regulation have a greater influence on the dominant firm's quality? Third, is regulation, imposed in the monopoly environment, still effective in the dominant firm - competitive fringe environment?

To conduct the analysis, I incorporate elements from the monopoly analysis in section 4.1 and the unregulated dominant firm - competitive fringe analysis in section 4.2.3. To begin, I will illustrate the monopoly environment with regulation. I assume that regulation is binding on the monopolist's price-quality selection. Namely, the minimum regulated quality level is above the unregulated monopolist level and the maximum regulated price level is below the unregulated monopolist level.\textsuperscript{120} I illustrate the monopolist's first order condition equations and isoprofit level curves. This is consistent

\textsuperscript{120} This is consistent with the public interest theory of regulation discussed in chapter 2.
with the analysis in section 4.1 on monopoly, quality, and regulation. By beginning with the monopoly environment with regulation, the analysis will be consistent with a market in transition from a regulated monopoly environment to a dominant firm - competitive fringe environment. With the monopoly and regulation in place, I introduce the dominant firm - competitive fringe adjustments. The first order condition equations shift from the monopoly positions. This is consistent with section 4.2.3 on the unregulated dominant firm - competitive fringe environment. I also incorporate the dominant firm’s isoprotfit level curves. This approach permits me to identify the final outcome in the dominant firm - competitive fringe environment, especially whether competition or regulation is more influential on the dominant firm’s quality selection.

- Quality Regulation

To begin, I will consider the dominant firm - competitive fringe environment with quality regulation. The competitive fringe can offer a low or high quality substitute. First, I will consider the scenario where the competitive fringe offer a low quality substitute. Figure 4.26 illustrates the outcome.
With the introduction of the competitive fringe offering a low quality substitute, there is no guarantee that the quality regulation imposed in the monopoly environment will remain binding on the dominant firm's quality selection. In figure 4.26, the quality regulation is no longer binding as the dominant firm has improved quality beyond the minimum regulated quality level in response to the low quality substitute from the competitive fringe (i.e., \( q^\text{DF} \) is greater than \( q^R \)). However, the quality regulation could remain binding, as a close inspection of figure 4.26 reveals. The outcome depends on (1) the stringency of the quality regulation imposed during the monopoly environment and (2) the amount that the
dominant firm is induced to improve quality in response to the competitive fringe.\footnote{As was mentioned in section 4.2.3, the relative shift in $\pi_q = 0$ and $\pi_p = 0$ will determine the amount that the dominant firm is induced to improve quality.} If the quality regulation remains binding, the dominant firm’s price will be lower than the monopoly price. This is seen by the intersection of $\pi^{DF}_p = 0$ with the quality constraint which is lower than the intersection of $\pi^M_p = 0$ with the quality constraint. This outcome is consistent with the proposition that if a dominant firm cannot alter quality, the firm is induced to lower its price with the presence of a competitive fringe. In summary, from the unregulated monopoly position, both quality regulation and competition from a competitive fringe offering a low quality substitute induce the firm to improve quality. However, it is uncertain which is more influential and whether the regulation remains binding in the dominant firm - competitive fringe environment.

The second scenario that I will consider incorporates the competitive fringe offering a high quality substitute where the dominant firm faces quality regulation. Figure 4.27 illustrates the outcome.
Figure 4.27: Monopoly and dominant firm with high quality competitive fringe substitute and quality regulation.

In this scenario, the quality regulation imposed during the monopoly environment remains binding on the dominant firm's quality selection. The presence of a competitive fringe offering a high quality substitute induces the dominant firm to lower quality below the unregulated monopolist level. Thus, the quality regulation that was binding in the monopoly environment will remain binding in a dominant firm - competitive fringe environment with a high quality substitute. However, the dominant firm's price will be lower than either the unregulated monopolist or the quality regulated monopolist. This is seen by the intersection of \( \pi^M_{p} = 0 \) with the quality constraint \( (q^R) \) which is lower than both \( P^M \), the unregulated monopoly level, and the intersection of \( \pi^M_{p} = 0 \) with the quality
constraint, the quality regulated monopolist level. Again, this is consistent with the
dominant firm - competitive fringe model where the competitive fringe supply reduces the
dominant firm's demand and induces a price reduction. In summary, from the unregulated
monopoly position, quality regulation induces an improvement in quality while
competition from a competitive fringe offering a high quality substitute induces a decrease
in quality. Thus, quality regulation imposed and binding in the monopoly environment will
remain influential in the dominant firm - competitive fringe environment.

- Price Regulation

Next, I will consider the dominant firm - competitive fringe environment with price
regulation. Again, the competitive fringe can offer a low or high quality substitute. First,
I will consider the scenario where the competitive fringe offers a low quality substitute.
Figure 4.28 illustrates the outcome.
Figure 4.28: Monopoly and dominant firm with low quality competitive fringe substitute and price regulation.

In this scenario, quality will improve from the unregulated and price regulated monopoly levels. With price regulation, the monopolist lowers quality. The dominant firm facing a competitive fringe offering a low quality substitute is induced to improve quality above the unregulated monopoly level (i.e., \( q^{DF} \) is greater than \( q^{M} \)) and establish a price bounded above and below the unregulated monopoly price. Thus, there will be an improvement in quality. The price regulation imposed in the monopoly environment in most instances remains binding on the dominant firm’s price.\(^{122}\) Unless the maximum regulated price

\(^{122}\) Figure 4.28 illustrates this scenario.
level is relatively high or the price competition from the competitive fringe especially fierce, the dominant firm’s price will remain above the maximum regulated price level. This implies that the price regulation remains binding on price in the dominant firm - competitive fringe environment. While the quality level will improve from the unregulated and price regulated monopoly levels, the presence of binding price regulation implies that quality will not increase as much as it would have with an unregulated dominant firm - competitive fringe environment (i.e., \( q^\text{DF} \) is greater than \( q^\text{PR} \)).\(^{123}\) Price regulation exerts a downward influence on the dominant firm’s quality level, in a manner similar to the monopolist. In summary, price regulation induces a reduction in quality from the unregulated position while competition from a competitive fringe offering a low quality substitute induces an improvement in quality.

The second scenario that I will consider incorporates the competitive fringe offering a high quality substitute where the dominant firm faces price regulation. Figure 4.29 illustrates the outcome.

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\(^{123}\) This is seen by comparing the quality level associated with the unregulated dominant firm - competitive fringe environment, represented by the intersection of \( q^\text{DF}_p \) and \( q^\text{DF}_q \) with the quality level associated with a dominant firm subject to price regulation, represented by the tangency of the isoprofit level curve and the price constraint.
Figure 4.29: Monopoly and dominant firm with high quality competitive fringe substitute and price regulation.

In this scenario, the dominant firm's quality level will decline from the unregulated and price regulated monopolist's quality level. Both the presence of a high quality substitute from the competitive fringe and price regulation encourage the firm to lower quality. With the introduction of the competitive fringe offering a high quality substitute, there is no guarantee that the price regulation imposed in the monopoly environment will bind the dominant firm's price selection or influence its quality selection. In figure 4.29, the price regulation is no longer binding as the dominant firm has lower quality and reduced price below the maximum regulated price level in response to the high quality substitute from the competitive fringe. In this instance, price regulation has no influence on the dominant
firm's quality level. However, the price regulation could remain binding, as a close inspection of figure 4.29 reveals. The outcome depends on (1) the stringency of the price regulation imposed during the monopoly environment and (2) the amount that the dominant firm is induced to reduce price and quality in response to the competitive fringe. If the price regulation remains binding, the price regulation will induce the dominant firm to further lower quality below the unregulated dominant firm - competitive fringe level. In summary, from the unregulated monopoly position, both price regulation and competition from a competitive fringe offering a high quality substitute induce the firm to lower quality. However, it is uncertain which is more influential.

- Price and Quality Regulation

Next, I will consider the dominant firm - competitive fringe environment with price and quality regulation. The competitive fringe can offer a low or high quality substitute. First, I will consider the scenario where the competitive fringe offer a low quality substitute. Figure 4.30 illustrates the outcome.
Figure 4.30: Monopoly and dominant firm with low quality competitive fringe substitute and price and quality regulation.

With the introduction of the competitive fringe offering a low quality substitute, there is no guarantee that the price and quality regulation imposed in the monopoly environment will bind the dominant firm's price or quality selection. In figure 4.30, the price and quality regulation are no longer binding as the dominant firm has increased its quality and reduced its price below the maximum regulated price level and minimum regulated quality level in response to the low quality substitute from the competitive fringe. However, the price or quality regulation, or both, could remain binding, as a close inspection of figure 4.30 reveals. The outcome depends on (1) the stringency of the price and quality regulation imposed during the monopoly environment and (2) the amount that the
dominant firm is induced to improve quality and reduce price in response to the competitive fringe. In summary, from the unregulated monopoly position, both price and quality regulation and competition from a competitive fringe offering a low quality substitute induce the firm to improve quality and lower price. However, it is uncertain which is more influential and whether the regulation remains binding and influences quality in the dominant firm - competitive fringe environment.

The second scenario that I will consider incorporates the competitive fringe offering a high quality substitute where the dominant firm faces price and quality regulation. Figure 4.31 illustrates the outcome.

![Graph](image)

Figure 4.31: Monopoly and dominant firm with high quality competitive fringe substitute and price and quality regulation.
In this scenario, the price and quality regulation imposed during the monopoly environment remain binding. The presence of a competitive fringe offering a high quality substitute induces the dominant firm to lower its price and quality below the unregulated monopolist level. While the price is lower than the unregulated monopolist level, and perhaps lower than the maximum regulated price level, the low price is only profit maximizing for the dominant firm if it also reduces its quality. Thus, the quality regulation remains binding on the dominant firm’s quality selection. Without the ability to reduce its quality, and in fact a mandate to improve quality from the unregulated monopoly level, the dominant firm’s profit maximizing price will exceed the maximum regulated price level. Thus, the price regulation will also remain binding on the dominant firm. In summary, from the unregulated monopoly position, price and quality regulation induces a reduction in price and an improvement in quality while competition from a competitive fringe offering a high quality substitute induces a decrease in price and quality. When these opposing forces are consider simultaneously, the price and quality regulation will remain binding and influential on quality in the dominant firm - competitive fringe environment.

- Rate-of-Return Regulation

Finally, I consider the dominant firm - competitive fringe environment with rate-of-return regulation. Again, the competitive fringe can offer a low or high quality substitute. First, I will consider the scenario where the competitive fringe offer a low quality substitute. As shown in figure 4.15, rate-of-return regulation causes a monopolist’s first
order conditions to shift. The first order condition with respect to quality \((\pi_q = 0)\) shifts to the right while the first order condition with respect to price \((\pi_p = 0)\) shifts down from the unregulated monopoly positions. This outcome is consistent to the dominant firm-competitive fringe environment with low quality substitutes. With the introduction of a competitive fringe, the first order condition with respect to quality \((\pi_q = 0)\) shifts to the right and the first order condition with respect to price \((\pi_p = 0)\) shifts down from the unregulated monopoly positions. Thus, regulation and competition have the same directional impact on the firm’s price and quality selection. However, it is not clear whether the regulation or competition will bind the firm’s selection. The outcome depends on (1) the stringency of the rate-of-return regulation and (2) the amount that the dominant firm is induced to improve quality in response to the competitive fringe. Second, I will consider the scenario where the competitive fringe offer a high quality substitute. Again, with rate-of-return regulation \(\pi_q = 0\) shifts to the right while \(\pi_p = 0\) shifts down from the unregulated monopoly positions. The introduction of a competitive causes \(\pi_p = 0\) to shift down as before. However, with a high quality substitute, \(\pi_q = 0\) shifts to the left. This implies that regulation and competition have offsetting influences on quality. From the unregulated monopoly position, the dominant firm’s quality under regulation will improve. However, the improvement in quality will be less than that occurring without the competitive fringe offering a high quality substitute.
4.2.5. Summary of Dominant Firm - Competitive Fringe, Quality, and Regulation

Unlike the monopoly environment in section 4.1, the outcomes in the dominant firm - competitive fringe environment are not well defined. In this summary, I will only consider the scenario where \( \pi_{qf} = \pi_{pq} \) is positive, as this is consistent with the local telephone industry. Table 4.4 reports the impact that the presence of a competitive fringe will have on a dominant firm's quality selection compared to the unregulated monopolist. Without knowledge of the type of competitive fringe substitutes, no definitive conclusions can be drawn.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Quality Substitute</th>
<th>High Quality Substitute</th>
<th>Both Low and High Quality Substitute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>Improve</td>
<td>Lower</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Price</td>
<td>Uncertain</td>
<td>Lower</td>
<td>Uncertain</td>
</tr>
</tbody>
</table>

Table 4.4: Impact of competitive fringe on a dominant firm compared to an unregulated monopolist.

A similar situation arises with regulation in the dominant firm - competitive fringe environment. In many instances, the impact of regulation is unclear. Table 4.5 reports whether regulation influences the dominant firm's quality selection, from the unregulated dominant firm - competitive fringe environment. This indicates whether the regulation,
imposed in the monopoly environment, remains effective in the dominant firm -
competitive fringe environment. The results indicate that no generalized conclusions can
be drawn. Regulation is influential in some instances and not in other instances. Further,
regulation is sometimes associated with improved quality and associated with lower
quality in other instances.

<table>
<thead>
<tr>
<th>Type of Regulation</th>
<th>Low Quality Substitute</th>
<th>High Quality Substitute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Regulation</td>
<td>Uncertain</td>
<td>Improve</td>
</tr>
<tr>
<td>Price Regulation</td>
<td>Lower</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Price and Quality Regulation</td>
<td>Uncertain</td>
<td>Improve</td>
</tr>
<tr>
<td>Rate-of-Return Regulation</td>
<td>Uncertain</td>
<td>Improve</td>
</tr>
</tbody>
</table>

Table 4.5. Impact of regulation on a dominant firm compared to an unregulated dominant firm.
CHAPTER 5

AN EMPIRICAL ANALYSIS OF LOCAL TELEPHONE QUALITY-OF-SERVICE

In this chapter, I examine the empirical evidence of local telephone quality-of-service. The empirical literature addressing local telephone quality-of-service is quite sparse, with only three articles and one dissertation addressing this important topic. I find that between 1991 and 1999 there has been a steady erosion in the quality of local telephone service. The major question to consider is what is the cause of the quality-of-service deterioration. I estimate regression equations that consider local telephone quality-of-service in both a monopoly and a dominant firm-competitive fringe environment with regulation. For the monopoly environment, the regression results indicate that price cap regulation and deregulation are associated with lower quality-of-service compared to rate-of-return and earnings sharing regulation. For the dominant firm-competitive fringe environment, the regression results are mixed with neither regulation or

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124 Unless otherwise indicated, throughout this chapter quality-of-service refers to people and process oriented quality as defined in section 3.2.4.

125 In addition to being consistent with the theory presented in chapter 4, by estimating regression equations for both the monopoly and dominant firm-competitive fringe environments, I mitigate the "competition effect pitfall" identified by Sappington and Weisman (1996). This pitfall arises when the analyst attributes entirely to regulation the effects that are due to both regulation and competition.
competition consistently associated with either lower or higher quality-of-service. Finally, I consider three exogenous variables that could influence local telephone quality-of-service. The empirical results indicate that modern infrastructure deployment is associated with lower quality-of-service while no conclusive evidence emerges regarding corporate mergers and labor unrest and quality-of-service.

5.1. Literature Review

The empirical literature addressing local telephone quality-of-service is quite sparse. To date, only three papers and one dissertation have empirically examined local telephone quality-of-service. Snow (1997) conducts a reliability assessment of the public switched telephone network that is consistent with the operations research-based concept of quality. While Snow does not examine the economic and regulatory variables that influence local telephone quality-of-service, the dissertation provides insights on the technical aspects of network reliability. Tardiff and Taylor (1993) and Ai and Sappington (1998) both examine local telephone quality-of-service as part of comprehensive reviews of the impact of regulation on firm performance. In addition to quality-of-service, the authors consider rate levels, profits and costs, investment and network modernization, and service availability. Given the comprehensive nature of the analyses, there is no development of structural models from theory to guide the empirical analyses. Roycroft

126 In Snow’s analysis, the public switched telephone network includes both the local and long distance components of the telephone network.
and Garcia-Murrilo (2000) examine Regional Bell operating company trouble reports as an indicator of network reliability and service quality. While their analysis is focused solely on quality-of-service, the authors also do not incorporate a structural model to guide their empirical analysis. These omissions lead to several weaknesses in the papers.

Snow conducts an operations research-based quality analysis of the public switched telephone network. The dissertation is operations research-based because of the internal focus on network reliability and the evaluation of quality through conformance to standards. The research is technology based, with no analysis of the economic or regulatory influences on local telephone quality-of-service. In the dissertation, the major research questions include (1) whether reliability is constant, improving, or deteriorating; (2) what factors help explain reliability; and (3) what are the immediate causes of faults. Snow addresses these research questions through an examination of fault residency, trends in faults between 1992 and 1996, and explanatory variables. Snow arrives at several interesting conclusions regarding the reliability of the public switched telephone network. First, approximately 50 percent of network faults are caused by the transmission facility (i.e., local loops, interoffice trunks, and long distance fiber) failures. Among transmission facility failures, the most common cause is a cable cut. A cable cut occurs when another company (e.g., a water utility) or the telephone company itself accidentally cuts a telephone cable while performing work in the immediate area where the telephone cable is buried. Second, approximately 35 percent of network faults are caused by switch failures. Switch failures are caused by both hardware and software problems. Third, there is a positive correlation between network faults and interoffice fiber optic cable but no
correlation between network faults and average switch size. According to Snow, the positive correlation between network faults and interoffice fiber optic cable implies a hazard risk caused by the increased concentration of network traffic over large fiber cables.\textsuperscript{127} However, the lack of correlation between network faults and average switch size indicates that greater software reliability is offsetting the hazard risk caused by the increased concentration in switches.

Tardiff and Taylor perform a relatively simple empirical analysis of quality-of-service under incentive regulation and conclude that quality-of-service in states with incentive regulation is no worse than in states without incentive regulation. The authors include four forms of regulation under the rubric of incentive regulation: banded rate-of-return, earnings sharing, price cap, and deregulation. This is a rather broad definition of incentive regulation\textsuperscript{128} and the authors offer no explanation as to why each of these forms of regulation would be expected to influence quality-of-service in a similar manner. In addition to these forms of economic regulation, the authors incorporate quality-of-service regulation. For their empirical analysis, the authors combine economic and quality-of-service regulation to classify states into three categories: incentive regulation with quality regulation, incentive regulation without quality regulation, and other (i.e., non-incentive regulation). The authors rely on Mercer Management Consulting’s \textsc{Scorecard}\textsuperscript{SM}

\textsuperscript{127} The capacity of fiber optic cable greatly exceeds the capacity of copper cable. The increased capacity allows the telephone company to aggregate traffic over a single fiber optic cable that in the past traveled over many copper cables. Thus, with the aggregation of traffic over a single fiber optic cable, a failure will impact a larger amount of traffic than the failure of a copper cable.

\textsuperscript{128} As mentioned in section 2.2.1, these plans provide different incentives to the firm.
database for their quality data. The central component of this database is an index of quality constructed so that a hypothetical company that is the best in every dimension of quality would receive a score of 100. The authors’ empirical analysis consists of comparing the quality index in 1990 and 1991 for the three categories of states. The results are presented in Table 5.1.

<table>
<thead>
<tr>
<th>State Category</th>
<th>1990</th>
<th>1991</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentive and Quality Regulation</td>
<td>62.8</td>
<td>64.7</td>
<td>3.9</td>
</tr>
<tr>
<td>Incentive Regulation</td>
<td>71.9</td>
<td>72.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Other</td>
<td>72.9</td>
<td>72.7</td>
<td>-0.2</td>
</tr>
</tbody>
</table>

Table 5.1: Quality index performance in 1990 and 1991 for categories of states (Tardiff and Taylor 1993).

From this analysis, the authors conclude that (1) explicit quality standards are effective (based on the 3.9 unit change in the incentive and quality regulation category) and (2) states with incentive regulation and without quality standards performed no worse than companies in states without incentive regulation (based on a comparison of the quality index in 1990 and 1991 for the incentive regulation and other states). There are two significant problems with the analysis. First, the authors are attributing a quality score to a discrete level of quality. However, in doing so the authors fail to control for other factors that could influence quality. In their analysis of other measures of firm performance, the
authors use a panel dataset with multiple regression analysis arguing that “the availability of a pooled cross-section time series (or panel) data base provides a powerful vehicle for isolating the effects of different regulatory treatment.” This approach is lacking in their analysis of quality-of-service. Second, the authors are attributing the change in the quality index between 1990 and 1991 to the regulatory policy. However, this approach would require that the authors only include those observations where the regulatory policy changed between 1990 and 1991 (i.e., a nonequivalent control group pretest - posttest design) rather than include all observations.

Ai and Sappington perform a multiple regression analysis and find mixed results regarding incentive regulation and quality-of-service. The authors consider four types of regulation: rate-of-return, rate case moratoria, earnings sharing, and price cap. While they include these four types of regulation separately in their multiple regression analysis as dummy variables, they offer no explanation as to why one would expect different quality-of-service under each type of regulation (i.e., they do not explain the incentives each type of regulation offers and the relationship to quality-of-service). Unlike Tardiff and Taylor, Ai and Sappington construct a panel dataset. The cross-section unit of analysis is the state-level Regional Bell operating company and the time series consists of yearly observations for the period 1992 to 1996. The authors examine five measures of quality-of-service as dependent variables: commitments met, installation time, trouble reports,

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131 Ai and Sappington also drop all observations from states with deregulation.
trouble delay, and complaints. The authors include as explanatory variables the regulatory policy, the amount competitive access provider (CAP) fiber deployed, whether the state public utility commission permits toll competition, the percent of digital switches, and the political affiliation of the governor. To estimate the multiple regression model, the authors use a fixed effects model. Because of a high degree of multicollinearity between state-level and time series dummy variables and demographic explanatory variables (e.g., per capita income, population), the demographic variables were excluded. Based on their multiple regression model, the authors conclude that (1) residential trouble delays are longer under price cap, earnings sharing, and rate case moratoria and (2) residential and business complaints are lower under these same types of regulation. "Thus, there is no systematic link between incentive regulation and service quality, broadly defined." There are several weaknesses with the analysis that draw into question the authors’ conclusions. First, they did not include price and quality-service regulation as explanatory variables that the theory presented in chapter 4 suggests are important. Second, they fail to distinguish between a monopoly and dominant firm - competitive fringe environment. The authors commingle observations from these two different environments. Third, they include several explanatory variables that appear inappropriate for an analysis of quality-

132 The authors gather these data from the Federal Communications Commission (FCC) Automated Reporting and Management Information System (ARMIS) 43-05 Report.

133 The authors regressed the cross-section and time series dummy variables on per capita income and population. The R-square for these regressions was 0.99 and 0.94, respectively, indicating a high degree of multicollinearity. The authors conclude that "this collinearity appears to arise because relevant explanatory variables change little or trend systematically over time." Ai and Sappington (1998): 7.

of-service. While the authors attempt to incorporate competition with the amount of CAP fiber and the presence of toll competition, these are relatively weak explanatory variables. CAPs compete with local telephone companies for long distance access, not local service, and the presence of toll competition is a rule based, not a market based, measure. The presence of network modernization, as measured by digital switches, only influences equipment and system oriented based quality-of-service. Finally, it is unclear how the political affiliation of the governor would influence a firm’s decision regarding its quality-of-service.

Roycroft and Garcia-Murriilo (2000) develop a panel dataset and perform multiple regression analysis to examine the impact of several explanatory variables on Regional Bell operating company trouble reports. According to the authors, trouble reports are a proxy measure for network reliability and service quality. The authors identify five factors that could influence trouble reports: competition, regulation, downsizing (or the number of employees), technology, and mergers. For competition, the authors consider the number of competitive local exchange carriers per business line. The inclusion of competitive local exchange carriers represents an improvement over the CAP fiber and presence of toll competition variables in Ai and Sappington. However, the explanatory variable, measured per business line, is inconsistent with their measure of total trouble reports per line. For regulation, the authors consider rate-of-return, price cap, and other incentive regulation. The authors offer no a priori predictions regarding the impact of the

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135 FCC provides minimal information on telephone company employment in the ARMIS 43-01 report. Of 48 state-level Regional Bell operating companies, the authors have employee counts for only 14 companies. The authors estimate, without an explanation of their approach, the number of employees for each of the remaining 36 state-level Regional Bell operating companies.
five factors on trouble reports. To perform the empirical analysis, the authors develop a panel dataset consisting of 48 state-level Regional Bell operating company cross-section observations for eight years. Their multiple regression analysis consisted of separate regressions for the following holding companies: Ameritech, Bell Atlantic, NYNEX, and Southwestern Bell. From their empirical analysis, the authors conclude that (1) service quality discrimination between business and residential consumers in response to competition may be occurring, (2) incentive regulation has not lead to systematic increases in network trouble, and (3) mergers and technology have a consistent impact on trouble reports. There are four weaknesses with the authors' analysis. First, they do not distinguish between the monopoly and dominant firm - competitive fringe environment nor do they develop a structural model to guide their empirical analysis. Thus, their empirical analysis does not consider the different incentives these market structures can have on the firm's decision to provide a given level of quality-of-service. Second, while the authors incorporate competition, their measure does not address the intensity of competition. Again, chapter 4 indicated that amount of competition can influence the firm's incentive. Third, they did not include price and quality-of-service regulation as explanatory variables.

\[136\] The authors consider competitive local exchange carriers per business line. This is superior to simply considering the number of competitive local exchange carriers because the measure controls for the size of the state. However, it does not incorporate the intensity of competition. For example, two states could have the same number of competitive local exchange carriers per line. However, the intensity of competition would be different if in one state the average competitor serves 100,000 lines and in the other state the average competitor serves 10,000 lines.
as the theory presented in chapter 4 suggests is important. Finally, while the authors acknowledge that quality is a multidimensional concept as discussed in chapter 3, their analysis only considers a single measure.

As this literature review illustrates, the empirical analysis of local telephone quality-of-service is quite limited. Snow’s analysis considers only the technological aspects of local telephone quality-of-service. The remaining articles do not consider the different environments in which local telephone companies can operate, both monopoly and dominant firm - competitive fringe, and the impact that these different environments can have on a firm’s incentive to provide quality-of-service. Additionally, the articles do not rely on a structural model of quality-of-service based on a theory of regulation, monopoly or competition, and quality. As a result of these two problems, the authors include spurious explanatory variables and do not differentiate the time period under study. Finally, only Ai and Sappington (1998) and Roycroft and Garcia-Murillo (2000) construct an appropriate panel dataset to examine the impact of regulation and competition on quality-of-service.

5.2. Overview of Local Telephone Quality Data

Minimal consistent quality-of-service data exists for the local telephone industry. The Federal Communications Commission (FCC), through its Automated Reporting and Management Information System (ARMIS), is the only entity collecting consistent quality-of-service data across a broad array of companies over an extended period of time. While
many state public utility commissions collect quality-of-service data for local telephone companies operating within their jurisdiction, these data are generally not consistent from one state to the next. As a result, I will rely on FCC’s ARMIS data for the empirical analysis in this chapter.

FCC’s ARMIS is a nationwide data collection program for the local telephone industry. Local telephone companies that meet ARMIS reporting requirements file annual ARMIS reports.\textsuperscript{137} There are nine ARMIS reports in total including the following: 43-01 Annual Summary Report that collects high level aggregate financial data, 43-05 Service Quality Report, 43-06 Customer Satisfaction Report, and 43-07 Infrastructure Report that collects data on investment in telecommunications equipment. The unit of analysis and the reporting requirements vary by report. In its recent \textit{Report and Order} addressing ARMIS reporting requirements, FCC said that ARMIS “permits the Commission to monitor industry trends and quantify effects of alternative regulation . . . [and] . . . are relied upon by many state commissions and used by the public.”\textsuperscript{138}

As mentioned above, two ARMIS reports pertain to quality-of-service (i.e., the 43-05 and 43-06 reports).\textsuperscript{139} The 43-05 Report is the primary quality-of-service report and collects data on five discrete areas: Table I Installation and Repair Intervals (Interexchange Access), Table II Installation and Repair Intervals (Local Service), Table

\begin{footnotesize}
\begin{itemize}
\item[\textsuperscript{137}] Federal Communications Commission (1999B), par. 8. In response to passage of the Telecommunications Act of 1996, FCC adopted this order to replace quarterly filings with annual filings.
\item[\textsuperscript{138}] Federal Communications Commission (1999B), par. 9.
\item[\textsuperscript{139}] The ARMIS 43-07 Report collects data useful for evaluating equipment and system oriented quality.
\end{itemize}
\end{footnotesize}
III Common Trunk Blockage, Table IV Total Switch Downtime, and Table V Service Quality Complaints. These are objective quality measures. The 43-06 Report collects data on the results of local telephone companies’ consumer satisfaction surveys. These are subjective quality measures. For both reports, the unit of analysis is the local telephone company's operation in a state, what FCC refers to as the study area level. Thus, local telephone companies with operations in multiple states that meet the reporting requirements must file a separate 43-05 and 43-06 report for each state. Regarding the reporting requirements, companies with revenues exceeding $112 million per year or companies operating under a price cap plan must file both the 43-05 and 43-06 report. Again citing FCC’s *Report and Order*, FCC said that the 43-05 and 43-06 reports were important for “the Commission, state commissions, and the public [to] monitor trends in the quality of service provided by price cap ILECs” especially given that service quality is a concern and that there has been “a decline in quality of service provided by price cap ILECs.”

In this chapter, I use six variables from the FCC ARMIS 43-05 and 43-06 reports. The first variable is installation commitments met (local service). This variable identifies the percent of orders for the installation of local telephone service that were completed by the commitment date (i.e., requests for new local telephone service

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140 Federal Communications Commission (1999B), pars. 36 and 38.

141 Several additional variables included in the FCC ARMIS 43-05 and 43-06 reports are not used in this chapter. In general, these variables are not used because the data have not been collected consistently over the period that I consider in this chapter or the specific variable reflects a subset of a variable already under consideration.
completed on or before the date the company committed to the consumer). The second variable is the average installation interval. This variable is the average number of business days between the date a service order is placed and the date the service order is complete (i.e., the amount of time between placing an order and receiving local telephone service). The third variable, trouble reports, is the number of complaints concerning service quality made by consumers to the company.\textsuperscript{142} The fourth variable is repeat trouble reports. This variable is the number of trouble reports that are unresolved within 30 days, either because the company has not addressed the initial trouble report or the trouble reappears after the company has addressed the initial trouble report.\textsuperscript{143} Service quality complaints, the fifth variable, is the number of complaints pertaining to service quality filed with state and federal regulatory authorities. It excludes complaints relating to billing,\textsuperscript{144} operator service providers, and 900 and 906 services.\textsuperscript{145} Finally, consumer satisfaction is the percent of consumers surveyed reporting that they are dissatisfied with the company’s installation, repair, or business office services. These six variables address a wide variety of quality-of-service problems encountered with local telephone service and include both objective and subjective measures.

\textsuperscript{142} To control for local telephone companies of different sizes, I consider trouble reports per 1,000 access lines. Thus, large companies, with more access lines and presumably more trouble reports, are measured in consistent units with small companies.

\textsuperscript{143} I measure repeat trouble reports as a percent of trouble reports to control for the size of the local telephone company.

\textsuperscript{144} Billing is a frequent complaint of consumers to state and federal regulators. For example, during the period July 1995 through June 2000, 41 percent of all complaints to the Nebraska Public Service Commission about telephone service concerned billing. Nebraska Public Service Commission 2000, 1.

\textsuperscript{145} I consider service quality complaints per 1,000 access lines to again control for the size of the local telephone company.
While not perfect, the FCC ARMIS service quality data provide the best mechanism for examining local telephone quality-of-service.\footnote{For example, FCC ARMIS data are filed by local telephone companies themselves and are not audited by FCC.} Many state public utility commissions collect quality-of-service data for local telephone companies operating in their jurisdictions. However, the variables considered and measurement requirements generally vary from state-to-state. In fact, the National Association of Regulatory Utility Commissioners recommended that FCC update the service quality monitoring program.\footnote{\textit{Federal Communications Commission (1999B), par. 36.}} In addition to providing consistent measures over an extended period, FCC ARMIS quality-of-service data are also readily available through FCC.

Given the paucity of other data sources, I rely on FCC ARMIS quality-of-service reports for the empirical analysis. The FCC ARMIS program applies a consistent definition for each variable across all local telephone companies. Thus, each quality-of-service variable should be consistently measured from one company and one state to another. This improves both the interval validity and reliability of the analysis. In addition, the program has been in place for a sufficient number of years and encompasses a large number of study areas to allow for the development of a large panel dataset. In this chapter, I examine quality-of-service over the period 1991 to 1999, except for average installation interval and consumer satisfaction where data are only available for the 1996 to 1999 period. For the cross-section component of the panel dataset, I choose the largest local exchange carrier operating in each state and the District of Columbia, excluding
Alaska.\textsuperscript{148} With the exception of Connecticut, Hawaii, and Nevada, where the carriers are Southern New England Telephone Company (SNET), GTE, and Sprint/United-Nevada, respectively, the Regional Bell operating company at the state level will be the unit of observation. However, because of inconsistent reporting over the period covered by this chapter, observations for NYNEX are excluded.\textsuperscript{149}

5.3. Trends in Local Telephone Quality-of-Service

Based on existing evidence, local telephone quality-of-service appears to be declining from the levels present in the early 1990s. News organizations and government agencies regularly report instances of quality problems or state and federal government action related to local telephone service. Additionally, FCC ARMIS data reveal a downward trend in quality-of-service. Of eight quality-of-service measures, seven indicate that quality is lower in 1999 than either 1991 or 1996, depending on the specific quality-of-service measure. Only one measure has shown improvement.

\textsuperscript{148} I exclude Alaska because no carrier in the state meets the filing requirements for either the 43-05 or the 43-06 report. In addition, given the vast distance between points in the state and its historical ties to military communications, the telephone network in Alaska is fundamentally different than that in the remaining 49 states and the District of Columbia.

\textsuperscript{149} In an analysis of local telephone service quality, the U.S. General Accounting Office excluded NYNEX because of "inconsistent data." Additionally, the report noted that FCC officials agreed that NYNEX data should not be included in the analysis. NYNEX is a Regional Bell operating company that serves New England and New York state. U.S. General Accounting Office (2000B), 23.
Public documents and news reports indicate that local telephone quality-of-service is becoming a problem. In a recent report, the U.S. General Accounting Office (GAO) reported that "two key indicators . . . raise concerns about the quality of telephone service." The GAO noted that "the number of customer complaints to state and federal regulators . . . increased after 1997 [and through 1999] to a significantly higher level than in 1996." Further, "most of the major ILECs [incumbent local exchange carriers] experienced increases in customer dissatisfaction in 1999." Regarding a specific Regional Bell operating company (RBOC), a wave of quality-of-service problems are currently plaguing Ameritech; an RBOC serving Ohio, Indiana, Illinois, Michigan, and Wisconsin. The Public Utilities Commission of Ohio has banned Ameritech-Ohio, Ameritech's local telephone company serving Ohio, from remitting a quarterly dividend to the parent corporation and ordered the company to provide more than $5.1 million in credits and waivers and spend $3.65 million "in a manner that benefits customers" for violating the state's quality-of-service standards. The Michigan Public Service Commission noted that the number of complaints has risen dramatically in that state while the Michigan Consumer Federation said that complaints had more than tripled in the last decade. The problems are not simply limited to Ameritech. The Washington Post
reported on quality-of-service problems at Verizon\textsuperscript{155} and noted that “basic telephone customers complain that they have been dispossessed by [local telephone] companies increasingly preoccupied with the Internet, wireless communications, and the next blockbuster deal.”\textsuperscript{156} These reports about quality-of-service problems are in addition to the near continual reporting of problems with US West’s service, the RBOC serving the nation’s middle and mountain regions.

FCC ARMIS data on installation commitments met indicate a slight decline in the percent of commitments for installation service that local telephone companies have met. Figure 5.1 illustrates the trend for residential, business, and total installation commitments met for the period 1991 to 1999. The percent of commitments to business consumers that local telephone companies meet has fallen from 98.8 percent in 1991 to 96.3 percent in 1999. For residential consumers, the decline has been far more modest, with commitments met falling from 99.1 percent in 1991 to 98.5 percent in 1999.

\begin{footnotesize}
\begin{itemize}
    \item[\textsuperscript{155}] Verizon is the name of the company formed by a merger of Bell Atlantic and GTE in 2000.
    \item[\textsuperscript{156}] Goodman (2000).
\end{itemize}
\end{footnotesize}
Figure 5.1: Weighted average installation commitments met for the largest local telephone company in each state and the District of Columbia, excluding Alaska and NYNEX companies.

The average installation interval has increased dramatically since 1996. Figure 5.2 illustrates the trend in the average installation interval for residential, business, and all consumers between 1996 and 1999. The average interval for installation of residential service increased 40.7 percent, from 1.1 days in 1996 to 1.5 days in 1999. For business consumers, the average interval for installation of service increased 21.2 percent, from 2.3 days in 1996 to 2.7 days in 1999. Overall, the average increase was 31.6 percent between 1996 and 1999. The average installation interval is closely related to installation commitments met. For example, a company can maintain its level of commitments met while providing slower installations (i.e., increasing the average installation interval) by
providing less stringent commitments for the installation of service.\textsuperscript{157} Given the trends in installation commitments met and average installation interval, it is possible to speculate that local telephone companies are not committing to install service as quickly as in the past for residential consumers. This would explain why the average installation interval has increased for both residential and business consumers, while the installation commitments met has declined only slightly for residential consumers compared to the larger decline for business consumers.

![Graph of installation interval](image)

Figure 5.2: Weighted average installation interval for the largest local telephone company in each state and the District of Columbia, excluding Alaska and NYNEX companies.

\textsuperscript{157} In some instances, state public utility commissions maintain rules on the length of time between receiving an order for the installation of service and the provision of that service.
Unlike other quality-of-service measures, consumer trouble reports has shown improvement during the 1991 to 1999 period.\textsuperscript{158} Figure 5.3 illustrates the trend in residential, business, and total consumer trouble reports. As is evident from figure 5.3, residential consumer trouble reports consistently exceed those for business consumers. Residential consumer trouble reports fell significantly during the early 1990s and have continued a modest downward trend since that time. Between 1991 and 1999, residential consumer trouble reports fell 22.2 percent, from 326 trouble reports per 1,000 access lines to 254. During the same period, business consumer trouble reports fell 20.2 percent, from 137 trouble reports per 1,000 access lines to 109.

\textsuperscript{158} As is discussed in section 5.4.4 below, this quality measure is closely associated with modern infrastructure deployment, a form of equipment and system oriented quality.
Figure 5.3: Weighted average consumer trouble reports per 1,000 access lines for the largest local telephone company in each state and the District of Columbia, excluding Alaska and NYNEX companies.

Unlike consumer trouble reports, repeat trouble reports have become worse during the 1991 to 1999 period. Repeat trouble reports indicate the local telephone company’s ability to successfully correct a problem once it arises.\textsuperscript{159} As figure 5.4 illustrates, both residential and business repeat trouble reports, as a percent of consumer trouble reports, have increased consistently. Residential repeat trouble reports have increased 80 percent, from 12.1 percent of residential trouble reports in 1991 to 21.7 percent in 1999. At the same time, business repeat trouble reports have increased 42.1 percent, from 13.8 percent

\textsuperscript{159} Thus, unlike total trouble reports, repeat trouble reports are a form of people and process oriented quality.
of business trouble reports to 19.6 percent. These results indicate that local telephone companies are having increasing difficulty resolving consumer service quality problems.

Figure 5.4: Weighted average repeat trouble reports as a percent of consumer trouble reports for the largest local telephone company in each state and the District of Columbia, excluding Alaska and NYNEX companies.

Consumer complaints to state and federal regulators have increased dramatically since 1991. Consumer complaints have increased 309.1 percent, from 0.07 per 1,000 access lines in 1991 to 0.27 in 1999. Unlike the other measures, a comparison of consumer complaints between residential and business consumers is inappropriate because a typical business consumer has more access lines (i.e., phone numbers) than does the
typical residential consumer. Thus, this measure would overstate residential consumer complaints relative to business consumer complaints.\textsuperscript{160} Figure 5.5 illustrates the trend in consumer complaints per 1,000 access lines. This trend is consistent with the evidence presented earlier from the government agencies and news organizations.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{chart.png}
\caption{Weighted average consumer complaints per 1,000 access lines for the largest local telephone company in each state and the District of Columbia, excluding Alaska and NYNEX companies.}
\end{figure}

\textsuperscript{160} For example, consider a local telephone switch serving 10 residential consumers, each with one line, and one business consumer with 10 lines. Thus, the switch is serving 11 consumers and 20 lines. Assume that the switch malfunctions for an extended period and that all 11 consumers complain to the state public utility commission. While the residential consumer complaints per access line is 1, the business consumer complaints per access line is 0.1. This occurs because FCC reports the number of access lines, not the number of consumers.
Finally, FCC's consumer satisfaction data indicate a general increase in the level of consumer dissatisfaction. The consumer satisfaction data are collected for three different local telephone services: installation, repair, and business office. Consumer dissatisfaction is higher in 1999 than in 1996 for each type of service and for each type of consumer: residential, small business, and large business. This appears to indicate that a widespread problem exists, one that is not confined to any one type of service or type of consumer (e.g., local telephone companies are not ignoring residential and small business consumers to focus their attention on large businesses). The first consumer satisfaction measure is installation services. The results are illustrated in figure 5.6. Since 1996, residential dissatisfaction has increased 74.7 percent, small business dissatisfaction has increased 128.5 percent, and finally large business dissatisfaction has increased 33.5 percent.
Figure 5.6: Weighted average consumer dissatisfaction with installation services for the largest local telephone company in each state and the District of Columbia, excluding Alaska, Sprint/United-Nevada, and NYNEX companies.

The second consumer satisfaction measure is repair service. Since 1996, residential consumer dissatisfaction with repair service has increased 47.5 percent, small business dissatisfaction has increased 96.4 percent, and large business dissatisfaction has increased 65.0 percent. Figure 5.7 illustrates the trend in consumer dissatisfaction with repair service.
Figure 5.7: Weighted average consumer dissatisfaction with repair services for the largest local telephone company in each state and the District of Columbia, excluding Alaska, Sprint/United-Nevada, and NYNEX companies.

The final consumer satisfaction measure concerns business office services. Again, this measure illustrates a deterioration in quality-of-service. Residential dissatisfaction with business office services has increased 39.7 percent since 1996, small business dissatisfaction has increased 230.7 percent, and large business dissatisfaction has increased 58.1 percent. Figure 5.8 provides evidence of the increased dissatisfaction.
Figure 5.8: Weighted average consumer dissatisfaction with business office services for the largest local telephone company in each state and the District of Columbia, excluding Alaska, Sprint/United-Nevada, and NYNEX companies.

The evidence presented in this section indicates a deterioration in local telephone quality-of-service during the 1991 to 1999 period. News organizations and government agencies have been reporting on increasing problems with consumer service. Of eight quality-of-service measures, seven indicate that quality-of-service is becoming worse. Thus, an important question for scholars and regulators concerns the reason for the quality-of-service problems. The next two sections will examine the impact of alternative regulation and competition on local telephone quality-of-service to see if these variables can shed light on the deterioration in quality-of-service.
5.4. The Monopoly, Quality, and Regulation Environment

In this section, I empirically examine the relationship between a monopoly environment, regulation, and quality-of-service. The theory of quality in a monopoly environment with regulation presented in chapter 4 provides both guidance on the empirical framework and hypotheses regarding local telephone quality-of-service. Using FCC and other public documents, I create a panel dataset consisting of state-level local telephone company observations for the period 1991 to 1999. I estimate four regression equations to examine the relationship between state public utility commission regulation and price and a local telephone company’s quality-of-service in a monopoly environment. I find that price cap/rate freeze regulation and deregulation are associated with lower quality-of-service than rate-of-return and earnings sharing regulation when no competitors are present, as predicted by the theory.

5.4.1. Integration of Theory and Empirical Analyses

The empirical analysis in this chapter follows the approach of the New Industrial Organization literature. This literature has two main characteristics. First, the empirical analysis exploits advances in economic theory. The economic theory provides the structural framework for the empirical analysis and the hypotheses to test. Second, the

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unit of analysis is the firm, rather than the industry. The firm-level analysis permits researchers to study the behavior within industries exhibiting imperfect competition. In this respect, this chapter fits into the New Industrial Organization literature. The theory of monopoly and competition, quality, and regulation presented in chapter 4 provides the framework and hypotheses for the empirical analysis of this and the following section. In addition, the empirical analysis examines within industry behavior, here at the state operating company level.

The monopolist's profit function is determined by the firm's demand and cost conditions. I will begin with market demand. Because the firm is a monopolist, it faces the entire market demand. Three factors influence market demand. From the theory, price and quality influence demand. Additionally, other factors such as population, per capita income, business intensity, etc. influence the amount of local telephone service demanded. Thus, I define market demand for local telephone service as follows.

\[ X = X(P,q,W) \]  

(5.1)

where \( X \) equals market demand, \( P \) equals price, \( q \) equals quality, and \( W \) equals a vector of other variables that influence demand. Similarly, three factors influence the monopolist's cost function. Quantity and quality were identified in the theory as influencing cost.

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162 This is in contrast to the dominant firm - competitive fringe environment where the dominant firm, the erstwhile monopolist, faces the residual demand (i.e., market demand less the aggregate competitive fringe supply).
Additionally, other variables, such as the firm’s technology, labor skills and costs, population density, etc., will influence the monopolist’s cost function. I define the cost function for a local telephone monopolist as follows.

\[ C = C(X, q, Z) \]  \hspace{1cm} (5.2)

where \( C \) equals cost and \( Z \) equals a vector of other variables that influence cost.

With the demand and cost functions identified, I can define the monopolist’s objective function. I assume that the monopolist will select price and quality to maximize profits (\( \pi \)). The monopolist will solve the following objective function.

\[ \max_{P, q} \pi^M = PX(P, q, W) - C(X, q, Z) \]  \hspace{1cm} (5.3)

where \( PX(P, q, W) \) is the firm’s revenue. However, in the local telephone industry, the monopolist is also subject to state public utility commission oversight. With the exception of Nebraska, all state public utility commissions impose some form of economic regulation, either rate-of-return, earnings sharing, price cap, or some combination of these and others. Additionally, many state public utility commissions also impose some form of quality regulation. Thus, in addition to equation 5.3, the following situations may also apply.
\[
\begin{align*}
\max_{p,q} \pi^M &= PX(p,q,W) - C(X,q,Z) \quad \text{s.t. } \pi/K \leq S \\
\max_{p,q} \pi^M &= PX(p,q,W) - C(X,q,Z) \quad \text{s.t. } q \geq q^R \\
\max_{p,q} \pi^M &= PX(p,q,W) - C(X,q,Z) \quad \text{s.t. } P \leq P^R
\end{align*}
\] (5.4) (5.5) (5.6)

and a combination of equation 5.5 with 5.4 and 5.6, where \( K \) equals capital, \( S \) equals the allowed rate-of-return, \( q^R \) equals the minimum regulated quality level, and \( P^R \) equals the maximum regulated price level. Equation 5.4 is the objective function with rate-of-return regulation, equation 5.5 includes quality regulation, and equation 5.6 includes price regulation. I will generically refer to state public utility commission regulation with the vector \( R \). Thus, the reduced form equation for the monopolist’s quality is as follows.

\[
q^M = q^M(p,W,Z,R)
\] (5.7)

Equation 5.7 suggests that a local telephone monopolist’s quality-of-service should be empirically estimated as a function of price, a vector of demand conditions, a vector of cost conditions, and a vector of state public utility commission regulatory mandates.

The theory of monopoly, quality, and regulation presented in chapter 4 also provides hypotheses regarding the monopolist’s quality choice. To begin, I assume that local telephone demand is inelastic and that inframarginal consumers’ valuation of quality
exceeds the marginal consumer's valuation of quality.\footnote{As was noted in chapter 4, several studies have found that demand for local telephone service is relatively inelastic. Further, businesses are generally the most intensive users of local telephone service and are therefore inframarginal consumers. Businesses' valuation of quality generally exceeds that of most individuals. This is evident in a National Regulatory Research Institute report that found that business/non-residential consumers were consistently more concerned about quality-of-service problems than were residential consumers (Lawton 1996).} This implies that \( \pi_{qP} = \pi_{Pq} \) is positive. Given this assumption, the following hypotheses emerge regarding a monopolist's quality-of-service and regulation in the local telephone industry. First, compared to an unregulated monopoly, the outcome under rate-of-return regulation is unclear. However, it would appear that the quality-of-service would most likely trend towards being better under rate-of-return than an unregulated environment. Second, compared to an unregulated environment, a monopolist operating under price regulation will provide worse quality-of-service. Third, the imposition of quality regulation, if binding, will necessitate improved quality-of-service. Figure 5.9 illustrates the hypotheses for economic regulation and local telephone quality-of-service.

\[\text{Unregulated}\]
\[\text{Worse} \quad \text{Price Regulation} \quad \text{Rate-of-Return Regulation} \quad \text{Better}\]

Figure 5.9: Hypotheses regarding the level of monopoly local telephone quality-of-service under price regulation, no regulation, and rate-of-return regulation.
Because only one state public utility commission relies on a deregulated (i.e., unregulated) mechanism, I consider companies operating under rate-of-return regulation compared to those operating under price regulation or deregulation. The theory suggests that local telephone quality-of-service will be higher under rate-of-return regulation.

5.4.2. Data

To empirically estimate a local telephone monopolist's quality-of-service, I consider the largest incumbent local exchange carrier (ILEC) operating in each state and the District of Columbia, excluding Alaska.164 This decision on the unit of analysis was necessitated by the nature of FCC’s ARMIS quality-of-service data. Namely, the data are gathered at the state operating company level. In addition, my source for state public utility commission regulation provides information at the state level (Abel and Clements 1998).

While the quality-of-service and regulatory policy variables are measured at the state level, many other variables are measured at a finer level and need to be aggregated to state-level service territories. I began by identifying the local access and transport areas (LATA) in each state and the major metropolitan area in each LATA. As was mentioned in chapter 2, LATAs are a construct of the Modification of Final Judgment, a consent decree that split American Telephone and Telegraph Company (AT&T) into a long

164 I define “largest” ILEC as the company with the most access lines in the state. In most instances, this will be the Regional Bell operating company. The exceptions are Southern New England Telephone Company in Connecticut, GTE in Hawaii, and Sprint/United in Nevada.
distance and research company, AT&T, and seven regional local telephone monopolies, the Regional Bell operating companies. Each LATA was created to correspond to an economic market.\textsuperscript{165} I accomplished this task by comparing the LATA boundaries in \textit{Notes on the BOC Intra-LATA Networks} with maps of each state that included county boundaries and metropolitan areas.

Once I had established the county-level boundary for each LATA and the major metropolitan area, I assigned one ILEC as the company serving the LATA.\textsuperscript{166} To accomplish this task, I used a two step process. First, I contacted relevant state public utility commissions and asked which ILEC served the most access lines in each LATA or, if that information was not available, which ILEC served the major metropolitan area in each LATA. A majority of states were willing and able to provide this information. Second, for states where I could not get information from the state public utility commission, I consulted the telephone book for the largest metropolitan area in the LATA. From the telephone book, I was able to discern which ILEC served that particular area. In all instances except one, I was able to assign a single ILEC to a LATA. The one exception was the Los Angeles LATA. Both Pacific Bell and GTE serve large portions of the greater Los Angeles area. Because Pacific Bell is the largest ILEC in the state of California and thus the ILEC under consideration in California, I included the Los Angeles

\textsuperscript{165} The creation of LATAs was a judicial, regulatory, and political process. The Regional Bell operating companies, most state public utility commissions, and FCC wanted relatively large LATAs to ensure sufficient intraLATA toll service to cross-subsidize local telephone rates. The Department of Justice wanted relatively small LATAs to foster as much competition in the overall telecommunications marketplace as possible.

\textsuperscript{166} In some instances, multiple ILECs can serve a given LATA.
LATA in Pacific Bell's state-level service territory. The ILEC's state-level service
territory in each state simply consists of all LATAs for which the company was assigned.

FCC reports the number of competitive local exchange carriers (CLEC) holding
number codes at the LATA level. To determine whether the ILEC encountered
competition from CLECs in the state and was thus no longer a monopolist, I aggregated
the number of competitors in all the LATAs served by the ILEC in each state. For
example, consider the case of Ameritech in the state of Ohio. Ameritech was the ILEC
considered in the analysis because it has the largest number of access lines of any ILEC
operating in Ohio. Ameritech was assigned as the ILEC serving the Akron, Cleveland,
Columbus, Dayton, and Toledo LATAs. Cincinnati Bell was assigned as the ILEC serving
the Cincinnati LATA and Sprint/United was assigned as the ILEC serving the
Lima/Mansfield LATA. In the fourth quarter of 1997, there were the following number of
CLECs holding number codes in the Ameritech LATAs: Akron-1, Cleveland-5,
Columbus-3, Dayton-1, and Toledo-2. Excluding multiple occurrences of a CLEC in the
LATAs (e.g., if AT&T were a competitor in both Cleveland and Columbus, it would be
counted only once rather than twice), there were nine competitors in Ameritech's Ohio
service territory in 1997.

In a similar manner, I calculated demographic data for the state-level service
territory of each ILEC. Using a variety of U.S. Census Bureau documents and datasets, I
could identify the land area, population, and median income for each county in a state.
These data were combined with the information I had on the counties comprising each
LATA. Thus, knowing which LATAs in a state the ILEC served, I could determine the
appropriate demographic data for the ILEC’s service territory. In most instances, the ILEC under consideration served most of the LATAs in a given state. Thus, I simply eliminated the counties in the LATAs that the ILEC did not serve to arrive at the service territory data. For example, with Ameritech in the state of Ohio, I simply eliminated the relevant demographic data for the counties in the Cincinnati and Lima/Mansfield LATAs from the state totals to arrive at the demographic data for Ameritech’s Ohio service territory.

For each cross-section unit of analysis, I collected the yearly data for the period 1991 to 1999. This long period of study is important for several reasons. First, it covers a period when a large number of state public utility commissions modified their regulatory policy (Abel and Clements 1998). During this period, many state public utility commissions switched from rate-of-return regulation to price cap regulation. Second, the long period of time allows for the analysis of trends occurring over time, versus a snapshot at a particular time.

The cross-section and time series observations form a panel dataset. The dataset has 450 observations. However, for the empirical analysis of local telephone quality-of-service in a monopoly environment, I only consider observations where the lag of the number of competitors is zero (i.e., the ILEC faces no CLEC competition). This is necessary to properly reflect the monopoly environment. The hypotheses developed in chapter 4 regarding the monopolist’s quality-of-service apply to a monopoly environment. Excluding observations where the lag of competitors is one or more leaves 245 observations.
5.4.3. Variables and Sources

Equation 5.7 indicates that four types of variables should be considered in an empirical analysis of local telephone quality-of-service in a monopoly environment. These variables are price, demand conditions, cost conditions, and regulatory conditions. The demand and cost conditions can be considered profit function conditions. Table 5.2 provides a summary of the variables collected and the sources. Below I discuss each in greater detail.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCOMT</td>
<td>the percent of installation orders for local telephone service that were completed by the commitment date for company-state i in year t</td>
<td>a</td>
</tr>
<tr>
<td>TINST</td>
<td>the average number of business days between the date a service order was placed and the date the service order was completed for company-state i in year t</td>
<td>a</td>
</tr>
<tr>
<td>TTRP</td>
<td>the number of complaints about service quality made to the company by consumers or end users per 1,000 access lines for company-state i in year t</td>
<td>a</td>
</tr>
<tr>
<td>TRTRP</td>
<td>the number of consumer trouble reports about service quality that are received within 30 days after the resolution of the initial trouble report per trouble report for company-state i in year t</td>
<td>a</td>
</tr>
<tr>
<td>TCOMP</td>
<td>the number of complaints filed with state and federal regulators about service quality per 1,000 access lines for company-state i in year t</td>
<td>a</td>
</tr>
<tr>
<td>REVLINE</td>
<td>basic local service revenue per access line divided by 12 for company-state i in year t (a proxy variable for price)</td>
<td>b</td>
</tr>
<tr>
<td>DENS</td>
<td>the population density in company-state i service territory in year t</td>
<td>c, d, e</td>
</tr>
<tr>
<td>INC</td>
<td>the per capita income in company-state i service territory in year t</td>
<td>f</td>
</tr>
<tr>
<td>URBAN</td>
<td>the percent of total residential access lines that are in MSAs in company-state i service territory in year t</td>
<td>a</td>
</tr>
<tr>
<td>BUSINT</td>
<td>the percent of total access lines that are business access lines for company-state i in year t</td>
<td>a</td>
</tr>
<tr>
<td>COMP</td>
<td>the number of CLEC's holding number codes in company-state i service territory in year t</td>
<td>g</td>
</tr>
<tr>
<td>LGCOMP</td>
<td>the one year lag of COMP</td>
<td></td>
</tr>
<tr>
<td>NONROR</td>
<td>a binary variable that equals 1 if the state public utility commission with jurisdiction over company i imposes either price cap or rate freeze regulation or does not regulate the company in year t and 0 otherwise</td>
<td>h</td>
</tr>
<tr>
<td>LGNONROR</td>
<td>the one year lag of NONROR</td>
<td></td>
</tr>
<tr>
<td>QSENF</td>
<td>a binary variable that equals 1 if the state public utility commission with jurisdiction over company-state i has imposed a financial penalty on an ILEC in its jurisdiction in the past in year t and 0 otherwise</td>
<td>i, j</td>
</tr>
<tr>
<td>LGQSENF</td>
<td>the one year lag of QSENF</td>
<td></td>
</tr>
</tbody>
</table>


Table 5.2: Definitions and sources for variables in local telephone monopoly quality-of-service analysis.
- Dependent Variables

As mentioned previously, I gathered the dependent variables that measure local telephone quality-of-service from FCC’s ARMIS 43-05 Report. TCOMT is the percent of installation orders for local telephone service that were completed by the commitment date for company-state i in year t. Improved quality-of-service is associated with a higher value for TCOMT because the company is providing more accurate estimates to consumers regarding service requests. TINST is the average number of business days between the date a service order was placed and the date the service order was completed for company-state i in year t. Improved quality-of-service is associated with a lower value for TINST because the company is providing more timely service. TTRP is the number of complaints concerning service quality made by consumers or end users per 1,000 access lines for company-state i in year t. I derive this value by dividing the total number of trouble reports for company-state i in year t by the number of access lines, in thousands, for the same company and year. Improved quality-of-service is associated with a lower value for TTRP because the company is experiencing fewer equipment and system problems. TRTRP is the number of consumer trouble reports concerning service quality that are received within 30 days after the resolution of the initial trouble report per trouble report for company-state i in year t. I derive this value by dividing the number of repeat trouble reports for company-state i in year t by the number of trouble reports for the same company and year. Improved quality-of-service is associated with a lower value for
TRTRP because the company is more successfully correcting equipment and system problems. Finally, TCOMP is the number of complaints filed with state and federal regulators concerning service quality per 1,000 access lines for company-state i in year t. I derive this value by dividing the total number of consumer complaints to state and federal regulators regarding company-state i quality-of-service in year t by the number of access lines, in thousands, for the same company and year. Improved quality-of-service is associated with a lower value of TCOMP because consumers are experiencing fewer problems that they feel the company is not addressing adequately and are therefore not calling government regulators.

- Explanatory Variables

The explanatory variables of most interest in this section concern state public utility commission regulation. For economic regulation, I include the variable LGNONROR. NONROR is a binary variable that equals 1 if company-state i in year t is subject to either price cap/rate freeze regulation or is deregulated. Price cap/rate freeze regulation and deregulation provide different incentives for the company than the other major forms of regulation, namely rate-of-return regulation and earnings sharing. With rate-of-return and earnings sharing regulation, the company either receives no benefit/cost or only minor benefit/cost from any change in its quality-of-service. With price cap/rate freeze regulation and deregulation, the company receives the full benefit/cost from any change. Further, because only one state public utility commission uses a deregulatory
framework, I combine both price cap/rate freeze regulation and deregulation into a single variable. Additionally, I use a one-year lag of NONROR to take into consideration that any change in quality-of-service, for example brought about by the elimination of service technicians, will take the company a period of time to implement. A change in quality-of-service will not occur immediately following a regulatory change. For quality regulation, I include the variable LGQSENF.\textsuperscript{167} QSENF is a binary variable that equals 1 if the state public utility commission that regulates company-state \( i \) has every imposed a financial penalty on any ILEC for poor quality-of-service. This variable indicates that the state public utility commission has enforceable standards regarding local telephone quality-of-service. Similar to NONROR, I include the one-year lag of QSENF to allow the company time to alter its programs in response to a regulatory change. Based on the theory presented in chapter 4 and section 5.4.1, I hypothesize that LGNONROR will be associated with lower quality-of-service and LGQSENF will be associated with higher quality-of-service.

Price is another important explanatory variable. An unregulated monopolist will select price and quality to maximize profits. With regulation, the state public utility commission will have an impact on price. Faced with either a market price or regulator-established price, the monopolist will select a quality-of-service level that maximizes profits. I include the variable REVLINE to serve as a proxy variable for price. REVLINE

\textsuperscript{167} In addition to being consistent with the theory presented in chapter 4, inclusion of this explanatory variable mitigates the "mandated versus motivated pitfall" identified by Sappington and Weisman (1996). This pitfall involves attributing to the incentive properties of regulation (i.e., motivation) outcomes that are actually mandated by regulation.
is the company's total basic local service revenue divided by total access lines, this creates a variable of revenue per line or customer, and divide this by 12 to arrive at the monthly "price" for basic local telephone service. This is the revenue a local telephone company collects for providing local telephone service, excluding advanced services such as call waiting, voice mail, etc. Based on the theory, I hypothesize a positive relationship between price and quality (i.e., higher prices are associated with higher quality-of-service).

The final group of variables that I consider in the analysis of local telephone quality-of-service concern the monopolist's profit function. As other authors have noted, rarely can one identify and measure the many variables that can influence a firm's profit function. I consider several variables that appear occasionally in the empirical telecommunications literature. DENS is the population density in the service territory served by company-state i in year t. I derive this variable by dividing the population by the land area for the state-level service territory. Since local telephone service less expensive to deploy in high density areas, some authors have speculated that population density could indirectly measure the firm's costs. INC is per capita income in company-state i service territory in year t. Some authors argue that higher per capita income will lead to greater demand for telecommunications services and therefore impact the demand for the firm's services.¹⁶⁸ URBAN is another variable similar to DENS. The variable measures the percent of company-state i consumers that live in metropolitan areas in year t. I derive this variable by dividing residential access lines that are in metropolitan statistical areas

¹⁶⁸ With a subscription rate exceeding 94 percent and relatively inelastic demand, it is doubtful how much influence per capita income has on local telephone service. This variable would appear more applicable to enhanced (e.g., caller ID, voice mail) and long distance services where demand is more elastic.
(MSAs) by total residential access lines. The final variable is BUSINT. This variable measures the relative distribution of company-state i consumers between businesses and residential. I derive this variable by dividing business access lines by total access lines. Some authors state that the relative amount of business to residential consumers will influence the company's incentives.

5.4.4. Estimation and Results

Econometric estimation with a panel dataset requires additional modeling beyond the typical ordinary least squares analysis. I assume that the slope coefficients are consistent across cross-sections and time. For example, the impact of non rate-of-return regulation will be similar across companies in various states and across time. The econometric model where slope coefficients are constant and the intercept varies by cross-section and time is as follows.

\[ Q_{it} = \beta_{1it} + \sum \beta_k X_{kit} + \epsilon_{it} \]  

(5.8)

where \( Q_{it} \) is a quality measure for cross-section i and time t, \( \beta_{1it} \) is an intercept that varies across cross-section i and time t, \( \beta_k \) is a constant slope coefficient, \( X_{kit} \) is a cross-section and time dependent explanatory variable, and \( \epsilon_{it} \) is the error term. Hsiao (1986) noted that pooling observations and estimating an equation such as equation 5.8 with ordinary least
squares can produce biased estimates. There are two modeling approaches that can be used to produce unbiased estimates with panel datasets of the form in equation 5.8: the fixed effects and random effects models (Judge et al. 1985). Both models assume the following form.

\[ Q_{it} = \beta_1 + \mu_{it} + \sum \beta_k X_{kit} + \varepsilon_{it} \]  

(5.9)

where \( \beta_1 + \mu_{it} \) is the \( i^{th} \) cross-section and \( t^{th} \) time series intercept, \( \beta_1 \) is the mean intercept, and \( \mu_{it} \) is the \( i^{th} \) cross-section and \( t^{th} \) time series deviation from the mean intercept. The fixed effects model assumes that \( \mu_{it} \) is fixed (e.g., there is a consistent intercept for each state-level ILEC and each year). To estimate a panel dataset with the fixed effects model, a dummy variable is included for every cross-section and every time series, excluding one cross-section and one time series.\(^{169}\) The random effects model assumes that \( \mu_{it} \) is a random variable. According to Judge et al. (1985), the fixed effects model should be used if inference is conditional (i.e., \( X_{it} \) is correlated with \( \mu_{it} \)), versus unconditional inference. This occurs when (1) the data cannot be regarded as a random sample from the entire population or (2) the researcher is interested in the characteristics of the cross-sections and time series. Since both conditions describe the nature of the data and my research interests, I adopt the fixed effects model for the estimation approach.

\(^{169}\) The dummy variables for one cross section and one time series must be excluded to prevent perfect collinearity and, therefore a singular matrix.
Multicollinearity occurs when a number of explanatory variables are highly correlated. According to Judge et al. (1985), multicollinearity can lead to the following problems: (1) difficulty precisely identifying the separate effects of the correlated variables, (2) statistically insignificant parameter estimates, and (3) parameter estimates very sensitive to the addition or deletion of a few observations or variables. As mentioned previously in section 5.1, Ai and Sappington (1998) encountered multicollinearity when they estimated RBOC quality-of-service with a panel dataset including demographic variables and using the fixed effects model. Specifically, the demographic variables were highly correlated with the state and time dummy variables. I encountered a similar situation. For example, when I regressed the cross-section and time series dummy variables on per capita income, the adjusted R-square was 0.999. As Ai and Sappington mention, this most likely occurred because the demographic variables change very little or trend systematically over time. Thus, per capita income or population density, since state rankings on these are generally consistent, can identify a state in a similar manner as a cross-section dummy variable. Given this multicollinearity problem, I follow the approach adopted by Ai and Sappington and exclude the demographic variables. I justify this exclusion because (1) the state level dummy variables are important in compensating for all profit function related factors, including demographic factors, and (2) the demographic variables are not central to the analysis (i.e., the focus of the analysis is the regulatory variables and variables related to the profit function are simply control variables whose purpose can be accomplished via the cross-section and time series dummy variables).
With the modeling approach specified, I can identify the regression equations. The regression equations for the four local telephone quality-of-service measures are as follows.

Total Commitments Met:

\[
TCOMT_t = \beta_1 + \beta_2 \text{LGNONROR}_{it} + \beta_3 \text{LGQSENF}_{it} + \\
\beta_4 \text{REVLINE}_{it} + \sum \beta_5 Y_t + \sum \beta_6 ST_t + \epsilon_{it}
\] (5.10)

Total Trouble Reports:

\[
TTRP_t = \beta_1 + \beta_2 \text{LGNONROR}_{it} + \beta_3 \text{LGQSENF}_{it} + \\
\beta_4 \text{REVLINE}_{it} + \sum \beta_5 Y_t + \sum \beta_6 ST_t + \epsilon_{it}
\] (5.11)

Total Repeat Trouble Reports:

\[
TRTRP_t = \beta_1 + \beta_2 \text{LGNONROR}_{it} + \beta_3 \text{LGQSENF}_{it} + \\
\beta_4 \text{REVLINE}_{it} + \sum \beta_5 Y_t + \sum \beta_6 ST_t + \epsilon_{it}
\] (5.12)

Total Consumer Complaints:

\[
TCOMP_t = \beta_1 + \beta_2 \text{LGNONROR}_{it} + \beta_3 \text{LGQSENF}_{it} + \\
\beta_4 \text{REVLINE}_{it} + \sum \beta_5 Y_t + \sum \beta_6 ST_t + \epsilon_{it}
\] (5.13)
where \( Y_t \) equals the dummy variable for year \( t \), \( ST_i \) equals the dummy variable for company-state \( i \), and \( \varepsilon \sim N(0, \sigma^2) \). As was mentioned previously, these equations were run for all observations where LGCOMP, the one-year lag of the number of CLECs holding number codes, equaled zero (i.e., the company under observation was a monopolist in the state). Table 5.3 presents the descriptive statistics for the relevant variables and table 5.4 presents the regression results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCOMT</td>
<td>246</td>
<td>98.7687</td>
<td>0.7938</td>
<td>95.7000</td>
<td>100.000</td>
</tr>
<tr>
<td>TTRP</td>
<td>246</td>
<td>237.9748</td>
<td>65.4129</td>
<td>115.6244</td>
<td>560.4541</td>
</tr>
<tr>
<td>TRTRP</td>
<td>246</td>
<td>0.1786</td>
<td>0.0771</td>
<td>0.0544</td>
<td>0.4486</td>
</tr>
<tr>
<td>TCOMP</td>
<td>246</td>
<td>0.1610</td>
<td>0.2359</td>
<td>0.0000</td>
<td>1.5937</td>
</tr>
<tr>
<td>LGNONROR</td>
<td>246</td>
<td>0.1626</td>
<td>0.3698</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>LGQSENF</td>
<td>246</td>
<td>0.6463</td>
<td>0.4791</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>REVLINE</td>
<td>246</td>
<td>25.9567</td>
<td>4.3955</td>
<td>16.9681</td>
<td>36.6919</td>
</tr>
<tr>
<td>Y92</td>
<td>246</td>
<td>0.1748</td>
<td>0.3806</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Y93</td>
<td>246</td>
<td>0.1748</td>
<td>0.3806</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Y94</td>
<td>246</td>
<td>0.1788</td>
<td>0.3840</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Y95</td>
<td>246</td>
<td>0.1504</td>
<td>0.3582</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Y96</td>
<td>246</td>
<td>0.1098</td>
<td>0.3132</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Note: Cross-section variables omitted for brevity.

Table 5.3: Descriptive statistics for local telephone monopoly quality-of-service analysis.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Commitments Met</th>
<th>Total Trouble Reports</th>
<th>Total Repeat Trouble Reports</th>
<th>Total Consumer Complaints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>96.8210</td>
<td>242.9932</td>
<td>-0.0420</td>
<td>0.2673</td>
</tr>
<tr>
<td></td>
<td>(0.7237)</td>
<td>(75.2013)</td>
<td>(0.0973)</td>
<td>(0.2844)</td>
</tr>
<tr>
<td>LGNONROR</td>
<td>-0.2379</td>
<td>-22.3137</td>
<td>0.0352</td>
<td>0.0544</td>
</tr>
<tr>
<td></td>
<td>(0.1303)</td>
<td>(13.5349)</td>
<td>(0.0175)</td>
<td>(0.0512)</td>
</tr>
<tr>
<td>LGQSENF</td>
<td>-0.1268</td>
<td>3.7898</td>
<td>0.0437</td>
<td>0.1920</td>
</tr>
<tr>
<td></td>
<td>(0.1951)</td>
<td>(20.2696)</td>
<td>(0.0262)</td>
<td>(0.0766)</td>
</tr>
<tr>
<td>REVLINE</td>
<td>0.0818</td>
<td>-0.8406</td>
<td>0.0039</td>
<td>-0.0147</td>
</tr>
<tr>
<td></td>
<td>(0.0259)</td>
<td>(2.6897)</td>
<td>(0.0034)</td>
<td>(0.0102)</td>
</tr>
<tr>
<td>Y92</td>
<td>-0.0399</td>
<td>-18.4940</td>
<td>-0.0161</td>
<td>0.0082</td>
</tr>
<tr>
<td></td>
<td>(0.0804)</td>
<td>(8.3532)</td>
<td>(0.0108)</td>
<td>(0.0352)</td>
</tr>
<tr>
<td>Y93</td>
<td>-0.2456</td>
<td>-21.9532</td>
<td>0.0251</td>
<td>0.0279</td>
</tr>
<tr>
<td></td>
<td>(0.0810)</td>
<td>(8.4184)</td>
<td>(0.0109)</td>
<td>(0.0318)</td>
</tr>
<tr>
<td>Y94</td>
<td>-0.4703</td>
<td>-43.4737</td>
<td>0.0820</td>
<td>0.1019</td>
</tr>
<tr>
<td></td>
<td>(0.0839)</td>
<td>(8.7210)</td>
<td>(0.0113)</td>
<td>(0.0330)</td>
</tr>
<tr>
<td>Y95</td>
<td>-0.5187</td>
<td>-42.2610</td>
<td>0.0552</td>
<td>0.1831</td>
</tr>
<tr>
<td></td>
<td>(0.0931)</td>
<td>(9.6759)</td>
<td>(0.0125)</td>
<td>(0.0366)</td>
</tr>
<tr>
<td>Y96</td>
<td>-0.3436</td>
<td>-45.6841</td>
<td>0.0661</td>
<td>0.0725</td>
</tr>
<tr>
<td></td>
<td>(0.1113)</td>
<td>(11.5654)</td>
<td>(0.0150)</td>
<td>(0.0437)</td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.7649</td>
<td>0.6262</td>
<td>0.5480</td>
<td>0.5890</td>
</tr>
</tbody>
</table>

Notes: standard errors in parentheses
a = significant at 1 percent level
b = significant at 5 percent level
c = significant at 10 percent level
cross-section estimates omitted for brevity

Table 5.4: Regression results for local telephone monopoly quality-of-service.
The results of the regression analysis in table 5.4 provide support for the theory presented in chapter 4. In terms of the explanation of the deviation of the dependent variables about the means, the model performs well with adjusted R-squares between 0.5486 and 0.7649. The most important explanatory variable is LGNONROR, the one-year lag of either price cap/rate freeze regulation or deregulation. Of the four regression equations, the parameter estimates have the correct sign in three instances and are statistically significant in two instances. The parameter estimate has the correct sign and is statistically significant for total commitments met, TCOMT, and total repeat trouble reports, TRTRP. In the case of total commitments met, LGNONROR is associated with the local telephone company meeting fewer commitments. Price cap/rate freeze regulation and deregulation are associated with an approximate 1 percent decrease in total commitments met compared to rate-of-return or earnings sharing regulation, at mean values. For repeat trouble reports, the impact is more pronounced. Price cap/rate freeze regulation and deregulation are associated with the local telephone company having approximately 20 percent more trouble reports not successfully cleared in 30 days compared to rate-of-return and earnings sharing regulation, at mean values. While not statistically significant, price cap/rate freeze regulation and deregulation are associated with nearly 36 percent more consumer complaints at mean values than rate-of-return or earnings sharing regulation, at mean values.

For total trouble reports, the parameter estimate has the opposite sign from that expected (i.e., the parameter estimate implies that price cap/rate freeze regulation and deregulation are associated with fewer trouble reports) and is not statistically significant.
At first blush, this appears problematic. However, additional consideration about the nature of trouble reports provides a possible explanation. Trouble reports are generally caused by equipment and system problems. These problems can arise from equipment and system failures or natural elements (e.g., storms). While natural elements most likely occur in a random manner, system failures will be related to the reliability of the telecommunications equipment. To test this hypothesis, I regressed TTRP on the percent of access lines with digital stored program controlled (DSPC) switches (i.e., digital, versus analog, switches) and the cross-section and time series dummy variables. As expected, the parameter estimate is negative and statistically significant at the 1 percent level. A one standard deviation (18.35 percentage point) increase in the percent of lines with DSPC switches (i.e., a more modern network) is associated with a 7 percent reduction in total trouble reports. This implies that total trouble reports are related to equipment and system oriented quality and the theory of a firm’s incentive to invest in modern infrastructure is a more appropriate approach to explain changes in total trouble reports than is a theory of people and process oriented quality-of-service under monopoly and regulation.¹⁷⁰

The parameter estimates for the remaining explanatory variables provide mixed results. First, the one-year lag of quality standards is associated with lower quality-of-service. This result is opposite of what the theory would imply. One possible explanation is that states with local telephone companies providing poor quality-of-service are more

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¹⁷⁰ The theory and empirical evidence regarding a local telephone company’s incentive to invest in modern infrastructure are examined in Greenstein, McMaster, and Spiller (1995) and Lee (1997).
likely to implement standards and that those standards are not particularly stringent.\textsuperscript{171} Rather than a dummy variable for quality-of-service standards, a better variable would include the stringency of the standard. However, because of insufficient data, I am limited to using the dummy variable approach which cannot address stringency. Second, the proxy variable for price has the correct sign in three of four instances. However, it is statistically significant in only one instance. Third, the time series dummy variables, which capture the influence on quality-of-service change over time not explained by the other variables, illustrate the same trends evident in section 5.3. Namely, quality-of-service is generally becoming worse since 1991, except for total trouble reports.

The results presented in this section indicate that some of the downward trend in quality-of-service presented in section 5.3 can be explained by regulation. Price cap/rate freeze regulation and deregulation appear to be associated with lower quality-of-service compared to rate-of-return and earnings sharing regulation. This is consistent with the theory of monopoly, quality, and regulation presented in chapter 4. However, quality-of-service regulation does not appear to significantly alter the firm’s decision on local telephone quality.

\textsuperscript{171} Zearfoss (1997) examines the incentives for state public utility commissions to impose quality-of-service standards with flexible regulation.
5.5. The Dominant Firm - Competitive Fringe, Quality, and Regulation Environment

In this section, I empirically examine the relationship between competition, regulation, and a dominant firm's quality-of-service. The theory of quality in a dominant firm - competitive fringe environment developed in chapter 4 provides both guidance on the empirical framework and hypotheses regarding local telephone quality-of-service. Using the same panel dataset as in the previous section, I estimate two sets of regression equations. The first set of regression equations are the monopoly regression equations applied to the dominant firm - competitive fringe environment. The second set of regression equations are unique to the dominant firm - competitive fringe environment. As predicted by the theory, I find that regulation and competition have a weak and unclear impact on the local telephone company's quality-of-service in a dominant firm - competitive fringe environment.

5.5.1. Integration of Theory and Empirical Analyses

In a manner consistent with the empirical analysis of a local telephone monopolist's quality-of-service, the theory of quality in a dominant firm - competitive fringe environment in chapter 4 provides the framework for the empirical analysis in this section. The starting point is the dominant firm's profit function. The dominant firm's residual demand and cost functions determine the firm's profit function. I will begin with the residual demand function. Residual demand is market demand less the aggregate
competitive fringe supply. Five factors influence residual demand. Of these, three factors determine the market demand function. These factors are price, quality, and a vector of other demand conditions (e.g., population, per capita income, business intensity), as identified previously in section 5.4.1. Two additional factors are related to the dominant firm’s competitive fringe environment and determine the amount of aggregate competitive fringe supply. The first factor is the number of competitive fringe firms or their market share. The greater the competitive fringe supply, the smaller will be the dominant firm’s residual demand. The second factor is the type of substitute the competitive fringe supply. As the theory in chapter 4 illustrated, low and high quality substitutes from the competitive fringe will influence the dominant firm’s quality selection in different ways.

Thus, I define the dominant firm’s residual demand for local telephone service as follows.

\[ X^R = X^R(P, q, W, N, F) \] (5.14)

where \( X^R \) equals the dominant firm’s residual demand, \( P \) equals price, \( q \) equals quality, \( W \) equals a vector of other variables that influence market demand, \( N \) equals the number of competitive fringe firms or their market share, and \( F \) equals a vector defining the nature of the competitive fringe substitutes.

\[ ^{172} \text{Assuming identical competitive fringe firms, a larger number of firms translates into a larger aggregate amount of competitive fringe supply.} \]
There is no significant difference in the cost function between the monopolist and the dominant firm. The factors that influence the cost function include quantity, quality, and various firm specific conditions (e.g., the firm's technology, labor skills and costs, population density). The only difference concerns the quantity. For the monopolist, quantity is determined by the market demand function while for the dominant firm quantity is determined by the residual demand function. Thus, I define the cost function for a local telephone dominant firm as follows.

\[ C = C(X^{R}, q, Z) \]  \( (5.15) \)

where \( C \) equals cost and \( Z \) equals a vector of other variables that influence cost.

With the residual demand and cost functions identified, I can define the dominant firm's objective function. I assume that the dominant firm will select a price and quality combination to maximize profits (\( \pi \)). The unregulated dominant firm will solve the following objective function.

\[ \max_{p,q} \pi^{DF} = PX^{R}(P,q,W,N,F) - C(X^{R}, q, Z) \]  \( (5.16) \)

where \( PX^{R}(P,q,W,N,F) \) is the dominant firm's revenue. While competition is developing in the former monopoly local telephone markets, the dominant firms (ILECs) remain subject to state public utility commission regulation. As shown in table 2.1, only one state
public utility commission has deregulated the ILEC’s rates in its jurisdiction, although most state public utility commissions have migrated towards alternative forms of economic regulation. Also, as shown in table 2.2, quality-of-service regulation is becoming increasingly common among state public utility commissions. Thus, regulation must be incorporated into the dominant firm’s objective function. The dominant firm can be subject to rate-of-return regulation, quality regulation, price regulation, or some combination of these forms of regulation. Thus, in addition to equation 5.16, the following situations may also apply.

\[
\begin{align*}
\text{Max } & \pi^{DF}_{P,q} = PX^R(P,q,W,N,F) - C(X^R,q,Z) \text{ s.t. } \frac{\pi^{DF}}{K} \leq S \\
\text{Max } & \pi^{DF}_{P,q} = PX^R(P,q,W,N,F) - C(X^R,q,Z) \text{ s.t. } q \geq q^R \\
\text{Max } & \pi^{DF}_{P,q} = PX^R(P,q,W,N,F) - C(X^R,q,Z) \text{ s.t. } P \leq P^R
\end{align*}
\]

(5.17) \quad (5.18) \quad (5.19)

and a combination of equation 5.18 with 5.17 and 5.19, where $K$ equals capital, $S$ equals the allowed rate-of-return, $q^R$ equals the minimum regulated quality level, and $P^R$ equals the maximum regulated price level. Equation 5.17 is the objective function with rate-of-return regulation, equation 5.18 includes quality regulation, and equation 5.19 includes
price regulation. In the same manner as the monopoly empirical analysis, I will generically refer to state public utility commission regulation with the vector $\mathbf{R}$. Thus, the reduced form equation for the dominant firm’s quality is as follows.

$$q^{DF} = q^{DF}(P, W, Z, N, F, R)$$  \hfill (5.20)

Equation 5.20 suggests that a local telephone dominant firm’s quality-of-service should be empirically estimated as a function of price, a vector of demand conditions, a vector of cost conditions, the number of competitive fringe firms or their market share, a vector identifying the nature of the competitive fringe quality substitutes, and a vector of state public utility commission regulatory mandates.

Unlike the theoretical analysis of a monopolist and quality, the theoretical analysis of a dominant firm and quality provides no unambiguous hypotheses regarding the dominant firm’s quality choice. The dominant firm’s quality choice is influenced by the type of competitive fringe substitute (e.g., either a low or high quality substitute), the amount of competition, and the nature and stringency of regulation. If the competitive fringe offer a low quality substitute, the unregulated dominant firm will improve quality. If the competitive fringe offer a high quality substitute, the unregulated dominant firm will lower quality. However, regulation can influence the dominant firm’s choice in some instances. Regulation will be binding and influence the dominant firm’s quality choice in the following scenarios: (1) quality regulation with a high quality competitive fringe substitute, (2) price regulation with a low quality competitive fringe substitute, and (3)
rate-of-return regulation with a high quality competitive fringe substitute. Regulation need not impact the dominant firm’s quality choice in the remaining five scenarios, although it could depending on the stringency of regulation and the impact of the competitive fringe competition. Thus, both the competition and regulation variables are likely not to be strongly associated with the dominant firm’s quality choice given the unsettled nature of the hypotheses.

5.5.2. Additional Data, Variables, and Sources

The panel dataset used in the empirical analysis of the dominant firm’s quality is very similar to that used in the monopoly empirical analysis. Thus, I will limit this discussion to the additions in the dataset. Again, the dataset has 450 observations, with the observations consisting of the largest ILEC’s operations in every state except Alaska for the period 1991 to 1999. However, for the empirical analysis of local telephone quality-of-service in a dominant firm - competitive fringe environment, I only consider observations where the lag of the number of competitors is greater than zero (i.e., the ILEC faces CLEC competition). This is necessary to properly reflect the dominant firm - competitive fringe environment. The hypotheses developed in chapter 4 regarding the dominant firm’s quality selection apply to a dominant firm - competitive fringe environment. Excluding observations where the lag of competitors is zero leaves 147 observations.
The variables used in this empirical analysis are also very similar to the variables used in the monopoly empirical analysis. Equation 5.20 indicates that six types of variables should be considered in an empirical analysis of local telephone quality-of-service in a dominant firm - competitive fringe environment. These variables are price, demand conditions, cost conditions, the number or market share of competitors, the nature of the competitors' substitutes, and regulatory conditions. The number or market share of competitors and the nature of the competitors' substitutes are additional types of variables used in the empirical analysis of local telephone quality-of-service in a dominant firm - competitive fringe environment and not in the monopoly environment. Table 5.5 provides a summary of the additional variables collected and the sources. Unfortunately, there is no variable available that measures the relative quality of competitors' service in the local telephone industry.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPS</td>
<td>the percent of number codes assigned to CLECs in company-state i service territory in year t</td>
<td>a</td>
</tr>
<tr>
<td>LGCOMPS</td>
<td>the one year lag of COMPS</td>
<td></td>
</tr>
<tr>
<td>COMBINE</td>
<td>an interaction effect equal to LGNONROR * LGCOMPS</td>
<td></td>
</tr>
<tr>
<td>AINTV</td>
<td>the average number of days for the installation of local telephone service for company-state i in year t</td>
<td>b</td>
</tr>
<tr>
<td>RID</td>
<td>the percent of residential consumers dissatisfied with installation service for company-state i in year t</td>
<td>b</td>
</tr>
<tr>
<td>RRD</td>
<td>the percent of residential consumers dissatisfied with repair service for company-state i in year t</td>
<td>b</td>
</tr>
<tr>
<td>RBOD</td>
<td>the percent of residential consumers dissatisfied with business office service for company-state i in year t</td>
<td>b</td>
</tr>
</tbody>
</table>


Table 5.5: Definitions and sources for additional variables in local telephone dominant firm - competitive fringe quality-of-service analysis.

As shown in table 5.5, there are three additional explanatory variables and four additional dependent variables. COMPS is the percent of number codes assigned to CLECs for company-state i service territory in year t. Local telephone companies are assigned number codes, or more generally “blocks” of telephone numbers, to assign to their consumers. COMPS measures the relative share of these number codes that are assigned to CLECs. If new consumers are gravitating towards CLECs or existing consumers are switching from ILECs to CLECs, the percent of number codes assigned to CLECs will increase. Thus, COMPS is a proxy for the market share of CLECs.\(^{173}\)

\(^{173}\) COMPS is an imperfect proxy for CLEC market share because the variable only measures the percent of new number codes assigned to CLECs and does not consider the preexisting stock of number codes.
LGCOMPS is the one year lag of COMPS. I include LGCOMPS in the analysis because ILECs will generally be unable to change their quality-of-service immediately due to a change in the relative market share of CLECs. COMBINE is an interaction effect equal to LGNONROR times LGCOMPS. Thus, COMBINE will equal 0 for all observations with rate-of-return regulation and will equal LGCOMPS for all observations with price cap/rate freeze regulation or deregulation. I include COMBINE to capture the impact of regulation and competition together. This is consistent with the theory presented in chapter 4, where an understanding of quality required knowledge of both regulation and competition. For the dependent variables, I include AINTV to measure the average number of days required for the ILEC to install local telephone service. This variable is a weighted average of the residential installation interval and the business installation interval. In addition, I include three variables that measure consumer satisfaction. As mentioned in chapter 3, people and process service quality can consist of both an objective and subjective component. By incorporating consumer satisfaction, I am addressing the subjective component of people and process service quality. RID is the percent of residential consumers surveyed who were dissatisfied with the installation service that they received from company-state i in year t. RRD is the percent of residential consumers surveyed who were dissatisfied with the repair service that they received from company-state i in year t. Finally, RBOD is the percent of consumers surveyed who were dissatisfied with the business office service that they received from company-state i in year t.

However, in comparing different observations, COMPS will indicate which observations have the greatest relative share of CLEC activity.
While these three variables are reported by FCC, the results are based on the ILECs' own consumer satisfaction surveys which can differ from company to company. Thus, the results from these variables likely have lower internal validity and reliability than results from the other variables included in the empirical analysis. In addition, while FCC reports the consumer satisfaction results for residential, small business, and large business consumers, I only include residential consumers because the number of survey observations for small business and large business consumers is relatively small.\textsuperscript{174}

5.5.3. Estimation and Results

Because I use the same panel dataset and variables for this empirical analysis and the monopoly empirical analysis, the estimation approaches are very similar. I will again use the fixed effects model and exclude demographic variables to eliminate multicollinearity with the state and time dummy variables. However, I will conduct two sets of regression analyses. First, I will apply the regression equations developed for the monopoly environment (equations 5.10 to 5.13) to observations in the dominant firm-competitive environment. An important hypothesis of this dissertation is that the incentives for a monopolist and dominant firm to provide quality will be different because the firms operate in different market structures. By applying the monopoly model regression equations to the dominant firm-competitive fringe environment, I can examine

\textsuperscript{174} For example, there are no results from US West states for the large business consumers.
whether any differences are present. Second, I will develop and test regression equations specifically for the dominant firm - competitive fringe environment, consistent with the reduced form equation (equation 5.20). This regression analysis will permit testing of the hypotheses developed in chapter 4. Table 5.6 presents the descriptive statistics for the relevant variables for both sets of regression analyses.
<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCOMT</td>
<td>147</td>
<td>98.3209</td>
<td>0.8760</td>
<td>94.5000</td>
<td>99.9000</td>
</tr>
<tr>
<td>TTRP</td>
<td>147</td>
<td>203.3117</td>
<td>50.6972</td>
<td>86.5170</td>
<td>357.5043</td>
</tr>
<tr>
<td>TRTRP</td>
<td>147</td>
<td>0.2314</td>
<td>0.0817</td>
<td>0.1026</td>
<td>0.4422</td>
</tr>
<tr>
<td>TCOMP</td>
<td>147</td>
<td>0.2747</td>
<td>0.3315</td>
<td>0.0000</td>
<td>1.8099</td>
</tr>
<tr>
<td>AINTV</td>
<td>140</td>
<td>1.6891</td>
<td>1.0264</td>
<td>0.3950</td>
<td>6.1199</td>
</tr>
<tr>
<td>RID</td>
<td>134</td>
<td>5.9141</td>
<td>2.4649</td>
<td>1.6100</td>
<td>17.9700</td>
</tr>
<tr>
<td>RRD</td>
<td>134</td>
<td>10.6746</td>
<td>4.7179</td>
<td>2.7500</td>
<td>26.0500</td>
</tr>
<tr>
<td>RBOD</td>
<td>134</td>
<td>5.2510</td>
<td>2.9788</td>
<td>0.6000</td>
<td>15.3000</td>
</tr>
<tr>
<td>LGCOMP</td>
<td>147</td>
<td>6.2449</td>
<td>5.9087</td>
<td>1.0000</td>
<td>38.0000</td>
</tr>
<tr>
<td>LGCOMPS</td>
<td>147</td>
<td>6.5163</td>
<td>6.7093</td>
<td>0.0000</td>
<td>28.2000</td>
</tr>
<tr>
<td>LGNONROR</td>
<td>147</td>
<td>0.5918</td>
<td>0.4932</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>LGQSENF</td>
<td>147</td>
<td>0.6531</td>
<td>0.4776</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>REVLINE</td>
<td>147</td>
<td>27.6982</td>
<td>4.6015</td>
<td>19.1142</td>
<td>41.0075</td>
</tr>
<tr>
<td>COMBINE</td>
<td>147</td>
<td>4.4293</td>
<td>6.6619</td>
<td>0.0000</td>
<td>28.2000</td>
</tr>
<tr>
<td>Y95</td>
<td>147</td>
<td>0.0476</td>
<td>0.2137</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Y96</td>
<td>147</td>
<td>0.1156</td>
<td>0.3209</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Y97</td>
<td>147</td>
<td>0.2381</td>
<td>0.4274</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Y98</td>
<td>147</td>
<td>0.2993</td>
<td>0.4595</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Y99</td>
<td>147</td>
<td>0.2993</td>
<td>0.4595</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Note: Cross-section variables omitted for brevity.

Table 5.6: Descriptive statistics for local telephone dominant firm - competitive fringe quality-of-service analysis.
A major distinction between the monopoly environment and the dominant firm - competitive fringe environment is the influence that regulation will have on the firm’s quality choice. In a monopoly environment, regulation will directly influence the monopolist’s quality choice. The empirical evidence in section 5.4 provides support for the hypothesis that regulation will influence a monopolist’s quality-of-service. In a dominant firm - competitive fringe environment, regulation will not directly influence the dominant firm’s quality choice in every scenario. Thus, a hypothesis arising from this research is that the regulation variable will be less consistent in both direction of the sign and statistical significance in the dominant firm - competitive fringe environment than in the monopoly environment. Table 5.7 provides the results from applying the monopoly regression equations (equations 5.10 to 5.13) to observations associated with the dominant firm - competitive fringe environment.

\[^{175}\text{Because the monopoly regression analysis only considered the quality-of-service measures TCOMT, TTRP, TRTRP, and TCOMP, I will not test the consumer satisfaction quality-of-service measures in this part of the analysis. These additional variables are considered in the second part of the dominant firm - competitive fringe regression analysis.}\]
<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Commits Met</th>
<th>Total Trouble Reports</th>
<th>Total Repeat Trouble Reports</th>
<th>Total Consumer Complaints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>99.5373</td>
<td>153.3461</td>
<td>0.1717</td>
<td>0.6943</td>
</tr>
<tr>
<td></td>
<td>(2.4700)</td>
<td>(47.3613)</td>
<td>(0.1218)</td>
<td>(0.4503)</td>
</tr>
<tr>
<td>LGNONROR</td>
<td>-0.4910</td>
<td>-5.9509</td>
<td>-0.0311</td>
<td>0.0665</td>
</tr>
<tr>
<td></td>
<td>(0.2771)</td>
<td>(5.3139)</td>
<td>(0.0167)</td>
<td>(0.0505)</td>
</tr>
<tr>
<td>LGQSENF</td>
<td>-0.1302</td>
<td>-24.9967</td>
<td>-0.0799</td>
<td>0.0442</td>
</tr>
<tr>
<td></td>
<td>(0.6505)</td>
<td>(12.4729)</td>
<td>(0.0321)</td>
<td>(0.1186)</td>
</tr>
<tr>
<td>REVLINE</td>
<td>0.0284</td>
<td>0.1059</td>
<td>0.0010</td>
<td>-0.0189</td>
</tr>
<tr>
<td></td>
<td>(0.0734)</td>
<td>(1.4078)</td>
<td>(0.0036)</td>
<td>(0.0134)</td>
</tr>
<tr>
<td>Y95</td>
<td>-0.1965</td>
<td>8.2384</td>
<td>-0.0306</td>
<td>-0.1163</td>
</tr>
<tr>
<td></td>
<td>(0.4141)</td>
<td>(7.9404)</td>
<td>(0.0204)</td>
<td>(0.0755)</td>
</tr>
<tr>
<td>Y96</td>
<td>0.2382</td>
<td>9.0361</td>
<td>0.0217</td>
<td>-0.1802</td>
</tr>
<tr>
<td></td>
<td>(0.2592)</td>
<td>(4.9699)</td>
<td>(0.0128)</td>
<td>(0.0473)</td>
</tr>
<tr>
<td>Y97</td>
<td>0.2508</td>
<td>-1.8889</td>
<td>-0.0182</td>
<td>-0.2182</td>
</tr>
<tr>
<td></td>
<td>(0.2077)</td>
<td>(3.9817)</td>
<td>(0.0102)</td>
<td>(0.0379)</td>
</tr>
<tr>
<td>Y98</td>
<td>0.1645</td>
<td>4.3216</td>
<td>-0.1337</td>
<td>-0.1356</td>
</tr>
<tr>
<td></td>
<td>(0.1652)</td>
<td>(3.1682)</td>
<td>(0.0081)</td>
<td>(0.0301)</td>
</tr>
</tbody>
</table>

Adjusted R-square | 0.4163 | 0.9359 | 0.8367 | 0.8645 |

Notes: standard errors in parentheses

- a = significant at 1 percent level
- b = significant at 5 percent level
- c = significant at 10 percent level
- cross-section estimates omitted for brevity

Table 5.7: Regression results for local telephone dominant firm - competitive fringe quality-of-service with monopoly empirical model.
The results for the critical regulation variable LGNONROR, the one year lag of price cap/rate freeze regulation or deregulation, are not as consistent in the dominant firm - competitive fringe environment as they are in the monopoly environment. In the monopoly environment, LGNONROR is consistently associated with lower quality-of-service, except for total trouble reports which were found to be associated with equipment and system oriented quality. In the dominant firm - competitive fringe environment, the results for LGNONROR are mixed. Among quality measures with statistically significant results for LGNONROR, the variable is associated with lower quality-of-service in one instance and higher quality-of-service in another instance. LGNONROR is associated with a 1 percent decline in installation commitments met (i.e., lower quality-of-service) at mean values. However, LGNONROR is associated with a 14 percent decrease in repeat trouble reports (i.e., higher quality-of-service) at mean values. Among quality measures where LGNONROR is not statistically significant, the results are also mixed. LGNONROR is associated with a 3 percent decrease in total trouble reports (i.e., higher quality-of-service) and associated with a 28 percent increase in total consumer complaints (i.e., lower quality-of-service), both a mean values. Thus, the results provide support for the hypothesis that regulation will be less influential in the dominant firm - competitive fringe environment.

The influence of the remaining explanatory variables is also mixed in the dominant firm - competitive fringe environment. The variable LGQSENF, the one year lag of enforceable quality-of-service regulations, is associated with lower quality-of-service in two quality measures, total commitments met and total consumer complaints, and
associated with higher quality-of-service in the remaining two quality measures, total trouble reports and repeat trouble reports. The relationship between the proxy variable for the monthly price of local telephone service, REVLINE, and quality-of-service also does not appear to be as influential in the dominant firm - competitive fringe environment as in the monopoly environment. This result is consistent with the analysis of quality in the dominant firm - competitive fringe environment. In the monopoly environment, quality and price are directly related through the demand function. In the dominant firm - competitive fringe environment, both quality and the competitive fringe supply will influence price. Thus, the relationship between quality and price should be weaker in the new environment.

- Dominant Firm - Competitive Fringe Regression Equations

To begin this analysis, I will specify the regression equations. I derive the regression equations from the reduced form equation for the dominant firm's quality choice (equation 5.20). This equation specifies the explanatory variables to include in the regression equations. As discussed in section 5.4, I will use the fixed effects model with the panel dataset. Also consistent with section 5.4, I will exclude the demographic variables to avoid multicollinearity caused by the correlation between the demographic

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176 The possible endogeneity problem identified in section 5.4 would remain in the dominant firm - competitive fringe environment. Namely, if quality-of-service problems are present, the state public utility commission could be more likely to have imposed penalties in the past.
variables and the cross-section and time series dummy variables in the fixed effects model. The regression equations for the eight local telephone quality-of-service measures are as follows.

Total Commitments Met:

\[
TCOMT_{it} = \beta_1 + \beta_2 \text{LGNONROR}_{it} + \beta_3 \text{LGQSENF}_{it} + \beta_4 \text{REVLINE}_{it} + \\
\beta_5 \text{LGCOMPS}_{it} + \beta_6 \text{COMBINE}_{it} + \sum \beta_i Y_i + \sum \beta_i ST_i + \varepsilon_{it} \tag{5.21}
\]

Average Installation Interval:

\[
A\text{INTV}_{it} = \beta_1 + \beta_2 \text{LGNONROR}_{it} + \beta_3 \text{LGQSENF}_{it} + \beta_4 \text{REVLINE}_{it} + \\
\beta_5 \text{LGCOMPS}_{it} + \beta_6 \text{COMBINE}_{it} + \sum \beta_i Y_i + \sum \beta_i ST_i + \varepsilon_{it} \tag{5.22}
\]

Total Trouble Reports:

\[
T\text{TRRP}_{it} = \beta_1 + \beta_2 \text{LGNONROR}_{it} + \beta_3 \text{LGQSENF}_{it} + \beta_4 \text{REVLINE}_{it} + \\
\beta_5 \text{LGCOMPS}_{it} + \beta_6 \text{COMBINE}_{it} + \sum \beta_i Y_i + \sum \beta_i ST_i + \varepsilon_{it} \tag{5.23}
\]

Total Repeat Trouble Reports:

\[
T\text{TRRP}_{it} = \beta_1 + \beta_2 \text{LGNONROR}_{it} + \beta_3 \text{LGQSENF}_{it} + \beta_4 \text{REVLINE}_{it} + \\
\beta_5 \text{LGCOMPS}_{it} + \beta_6 \text{COMBINE}_{it} + \sum \beta_i Y_i + \sum \beta_i ST_i + \varepsilon_{it} \tag{5.24}
\]
Total Consumer Complaints:

\[ TCOMP_{it} = \beta_1 + \beta_2LGNONROR_{it} + \beta_3LGGQSENF_{it} + \beta_4REVLINE_{it} + \beta_5LGCOMPS_{it} + \beta_6COMBINE_{it} + \sum \beta_i Y_t + \sum \beta_i ST_i + \varepsilon_{it} \]  
(5.25)

Residential Consumer Dissatisfaction with Installation Service:

\[ RID_{it} = \beta_1 + \beta_2LGNONROR_{it} + \beta_3LGGQSENF_{it} + \beta_4REVLINE_{it} + \beta_5LGCOMPS_{it} + \beta_6COMBINE_{it} + \sum \beta_i Y_t + \sum \beta_i ST_i + \varepsilon_{it} \]  
(5.26)

Residential Consumer Dissatisfaction with Repair Service:

\[ RRD_{it} = \beta_1 + \beta_2LGNONROR_{it} + \beta_3LGGQSENF_{it} + \beta_4REVLINE_{it} + \beta_5LGCOMPS_{it} + \beta_6COMBINE_{it} + \sum \beta_i Y_t + \sum \beta_i ST_i + \varepsilon_{it} \]  
(5.27)

Residential Consumer Dissatisfaction with Business Office Service:

\[ RBOD_{it} = \beta_1 + \beta_2LGNONROR_{it} + \beta_3LGGQSENF_{it} + \beta_4REVLINE_{it} + \beta_5LGCOMPS_{it} + \beta_6COMBINE_{it} + \sum \beta_i Y_t + \sum \beta_i ST_i + \varepsilon_{it} \]  
(5.28)

where \( Y_t \) equals the dummy variable for year \( t \), \( ST_i \) equals the dummy variable for company-state \( i \), and \( \varepsilon \sim N(0, \sigma^2) \).\(^{177}\) As was mentioned previously, these equations were run for all observations where LGCOMP, the one-year lag of the number of CLECs

\(^{177}\) For the quality measures average installation interval (AINTV) and residential consumer dissatisfaction with installation service (RID), repair service (RRD), and business office service (RBOD), data are only available for the period 1996 to 1999. Thus, there is no 1995 dummy variable (Y95) for these quality measures.
holding number codes, was greater than zero (i.e., the company under observation encountered competition in the state). Table 5.8 presents the regression results for the objective quality measures and table 5.9 presents the regression results for the subjective quality measures.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Commitments Met</th>
<th>Average Installation Interval</th>
<th>Total Trouble Reports</th>
<th>Total Repeat Trouble Reports</th>
<th>Total Consumer Complaints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>98.8758&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-1.7882</td>
<td>155.8599&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.1061</td>
<td>0.5333</td>
</tr>
<tr>
<td></td>
<td>(2.4376)</td>
<td>(1.9296)</td>
<td>(50.3958)</td>
<td>(0.1232)</td>
<td>(0.4776)</td>
</tr>
<tr>
<td>LGNONROR</td>
<td>-0.0234</td>
<td>0.0349</td>
<td>-5.1033</td>
<td>-0.0068</td>
<td>0.0974</td>
</tr>
<tr>
<td></td>
<td>(0.3080)</td>
<td>(0.2593)</td>
<td>(6.3672)</td>
<td>(0.0156)</td>
<td>(0.0604)</td>
</tr>
<tr>
<td>LGQSENF</td>
<td>0.1981</td>
<td>-0.0237</td>
<td>-24.6964&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.0602&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.0752</td>
</tr>
<tr>
<td></td>
<td>(0.6274)</td>
<td>(0.5752)</td>
<td>(12.9685)</td>
<td>(0.0317)</td>
<td>(0.1229)</td>
</tr>
<tr>
<td>REVLINE</td>
<td>-0.0106</td>
<td>0.1076&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.0697</td>
<td>0.0026</td>
<td>-0.0156</td>
</tr>
<tr>
<td></td>
<td>(0.0706)</td>
<td>(0.0548)</td>
<td>(1.4577)</td>
<td>(0.0036)</td>
<td>(0.0138)</td>
</tr>
<tr>
<td>LGCOMPS</td>
<td>-0.0118</td>
<td>-0.0176</td>
<td>-0.2290</td>
<td>-0.0011</td>
<td>0.0058</td>
</tr>
<tr>
<td></td>
<td>(0.0306)</td>
<td>(0.0230)</td>
<td>(0.6320)</td>
<td>(0.0016)</td>
<td>(0.0060)</td>
</tr>
<tr>
<td>COMBINE</td>
<td>-0.0629&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.0051</td>
<td>-0.0788</td>
<td>-0.0036&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.0053</td>
</tr>
<tr>
<td></td>
<td>(0.0267)</td>
<td>(0.0206)</td>
<td>(0.5528)</td>
<td>(0.0014)</td>
<td>(0.0052)</td>
</tr>
<tr>
<td>Y95</td>
<td>-0.7516</td>
<td>-</td>
<td>4.4877</td>
<td>-0.0368</td>
<td>-0.0662</td>
</tr>
<tr>
<td></td>
<td>(0.5100)</td>
<td>-</td>
<td>(10.5413)</td>
<td>(0.0258)</td>
<td>(0.0999)</td>
</tr>
<tr>
<td>Y96</td>
<td>-0.4642</td>
<td>-0.2223</td>
<td>5.2092</td>
<td>0.0062</td>
<td>-0.1458&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(0.3799)</td>
<td>(0.2854)</td>
<td>(7.8520)</td>
<td>(0.0192)</td>
<td>(0.0744)</td>
</tr>
<tr>
<td>Y97</td>
<td>-0.1713</td>
<td>-0.0544</td>
<td>-4.2773</td>
<td>-0.0268&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.1948&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(0.2698)</td>
<td>(0.2033)</td>
<td>(5.5769)</td>
<td>(0.0136)</td>
<td>(0.0529)</td>
</tr>
<tr>
<td>Y98</td>
<td>-0.01517</td>
<td>0.0739</td>
<td>3.2720</td>
<td>-0.0167&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.1246&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(0.1759)</td>
<td>(0.1322)</td>
<td>(3.6263)</td>
<td>(0.0089)</td>
<td>(0.0345)</td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.4899</td>
<td>0.7933</td>
<td>0.9349</td>
<td>0.8401</td>
<td>0.8633</td>
</tr>
</tbody>
</table>

Notes: standard errors in parentheses

- a = significant at 1 percent level
- b = significant at 5 percent level
- c = significant at 10 percent level
- cross-section estimates omitted for brevity

Table 5.8: Regression results for local telephone dominant firm - competitive fringe quality-of-service with objective measures.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Residential Installation Dissatisfaction</th>
<th>Residential Repair Dissatisfaction</th>
<th>Residential Business Office Dissatisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.6691 (8.2436)</td>
<td>-7.2445 (13.3083)</td>
<td>-5.7824 (7.7655)</td>
</tr>
<tr>
<td>LGNONROR</td>
<td>1.0849 (1.1048)</td>
<td>2.8748 (1.7835)</td>
<td>0.9664 (1.0407)</td>
</tr>
<tr>
<td>LGQSENF</td>
<td>-1.1748 (2.3898)</td>
<td>0.0821 (3.8581)</td>
<td>0.3379 (2.2512)</td>
</tr>
<tr>
<td>REVLINEx</td>
<td>0.2367 (0.2360)</td>
<td>0.4780 (0.3803)</td>
<td>0.2269 (0.2223)</td>
</tr>
<tr>
<td>LGCOMPS</td>
<td>0.2163b (0.0972)</td>
<td>0.4272a (0.1569)</td>
<td>0.2063b (0.0916)</td>
</tr>
<tr>
<td>COMBINE</td>
<td>-0.2537a (0.0817)</td>
<td>-0.4055a (0.1407)</td>
<td>-0.2816a (0.0821)</td>
</tr>
<tr>
<td>Y96</td>
<td>0.1795 (1.2024)</td>
<td>2.5254 (1.9412)</td>
<td>0.6169 (1.1327)</td>
</tr>
<tr>
<td>Y97</td>
<td>-1.7635b (0.8669)</td>
<td>-3.030b (1.3994)</td>
<td>-1.0670 (0.8166)</td>
</tr>
<tr>
<td>Y98</td>
<td>-1.2770b (0.5623)</td>
<td>-2.3018b (0.9078)</td>
<td>-0.2881 (0.5297)</td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.3823</td>
<td>0.5606</td>
<td>0.6247</td>
</tr>
</tbody>
</table>

Notes: standard errors in parentheses
a = significant at 1 percent level
b = significant at 5 percent level
c = significant at 10 percent level
cross-section estimates omitted for brevity

Table 5.9: Regression results for local telephone dominant firm - competitive fringe quality-of-service with subjective measures.
The regression results presented in tables 5.8 and 5.9 provide support for the theory developed in chapter 4 and the hypotheses outlined in section 5.5.1. Specifically, the regression results indicate mixed signs and less statistical significance for the critical regulation and competition variables. In the case of the regulation variable, this result is contrary to the monopoly regression results. This indicates that there are differences in the dominant firm - competitive fringe environment and the monopoly environment. The regression results are also consistent across the objective and subjective quality measures. There are two possible explanations for this outcome. Either the incentives for the firm do not differ significantly between the objective and subjective quality measures or, with a large number of sample observations, the subjective perception of individual consumers becomes less important (i.e., there is a convergence). Finally, in terms of explanation of the deviation of the dependent variables about the means, the model performs well with adjusted R-squares between 0.3823 and 0.9349.

Both the regulation and competition variables illustrate mixed results, consistent with the hypotheses discussed earlier. To begin, I will consider the interaction effect variable, COMBINE. The parameter estimate simply measures the joint effect of price cap/rate freeze regulation or deregulation (LGNONROR) and competition (LGCOMPS). When either price cap/rate freeze regulation or deregulation is present, increased competition is associated with improved quality on six measures and worse quality on two measures. This implies that competition could be offsetting some of the negative implications arising from price cap/rate freeze regulation and deregulation. However, to understand the complete impact of LGNONROR and LGCOMPS, I must not only
consider the parameter estimate for COMBINE but also the parameter estimates for the individual effects (i.e., LGNONROR and LGCOMPS).\textsuperscript{178} Thus, the variable COMBINE is important when considered in combination with other parameter estimates. COMBINE is statistically significant for five of eight quality measures. This is important because it can influence standard errors on the marginal effect for the overall impact of LGNONROR and LGCOMPS.

Next, I will consider the one year lag of price regulation or deregulation, LGNONROR. This parameter estimate measures the impact of LGNONROR alone, without considering the interaction with competition. The parameter estimates are inconsistent across the various quality measures. LGNONROR alone is associated with improved quality-of-service with the total trouble reports and total repeat trouble reports. LGNONROR alone is associated with lower quality-of-service with the total commitments met, average installation interval, total consumer complaints, and residential dissatisfaction with installation, repair, and business office service quality measures. Further, the parameter estimate is not statistically significant. When I consider the overall effects of LGNONROR (i.e., $\beta_2 + \beta_6 \times$ LGCOMPS), the results are also mixed. To consider the change associated with adoption of price cap/rate freeze regulation or deregulation versus rate-of-return regulation, I compare the change in the quality measure when LGNONROR is altered from 0 to 1, with all remaining variables at mean values. The change is

\textsuperscript{178} For example, consider the marginal impact of LGCOMPS on TCOMT. Without the variable COMBINE, the marginal effect is simply $\delta E(TCOMT)/\delta LGCOMPS = \beta_5$. By including COMBINE, the marginal effect becomes $\delta E(TCOMT)/\delta LGCOMPS = \beta_5 + \beta_6 \times$ (LGNONROR). Thus, consideration of $\beta_5$ and $\beta_6$ alone does not fully explain the impact of competition, as measured by LGCOMPS. Green (1993), 391
associated with lower quality with four quality measures: TCOMT a 1 percent decline, AINTV a 4 percent increase, TCOMP a 26 percent increase, and RRD a 2 percent increase. The change is associated with higher quality with four measures: TTRP a 3 percent decrease, TRTRP a 12 percent decrease, RID a 9 percent decrease, and RBOD a 15 percent decrease. These results indicate that regulation is associated with a mixed impact on quality in the dominant firm - competitive fringe environment.

Next, I will consider a proxy for the one year lag of market share of CLECs, LGCOMPS. This parameter estimate measures the impact of LGCOMPS alone, without considering the interaction with regulation. LGCOMPS alone is associated with improved quality-of-service with the average installation interval, total trouble reports, and total repeat trouble reports. LGCOMPS alone is associated with lower quality-of-service with the total commitments met, total consumer complaints, and residential consumer dissatisfaction with installation, repair, and business office service quality measures. The parameter estimates are only statistically significant with the three subjective quality measures. Considering the overall impact of LGCOMPS (i.e., $\beta_3 + \beta_6 \times LGNONROR$), the results are also mixed. To consider the impact of an increase in competition, I compare the change in each quality measure when LGCOMPS is increased by one standard deviation from the mean value, with all other variables at mean values. The increased market share for competitors is associated with lower quality for five quality

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179 In addition to the percent of new number codes received by CLECs with a one year lag, LGCOMPS, I also tested the dominant firm - competitive fringe regression equations with the number CLECs in a market also with a one year lag. The results were qualitatively similar in both sets of estimations.
measures: TCOMT a 1 percent decrease, TCOMP a 7 percent increase, RID a 7 percent increase, RRD a 12 percent increase, and RBOD a 5 percent increase. The increased market share for competitors is associated with higher quality for three measures: AIINTV a 6 percent decrease, TTRP a 1 percent decrease, and TRTRP a 3 percent decrease. Again, these results are consistent with the hypothesis that competition will have a mixed impact on the dominant firm’s quality-of-service.

The regression results for the remaining explanatory variables are mixed, generally consistent with the monopoly environment. The variable LGQSENFD, whether a state public utility commission has imposed a financial penalty for quality-of-service problems in the past with a one-year lag, is only statistically significant for the total trouble report and total repeat trouble report quality measures. The variable is associated with fewer trouble reports and a higher level of repeat trouble reports. Consistent with the monopoly environment, endogeneity could be present with the interaction between the level of quality and the likelihood of a public utility commission imposing financial penalties in the past. The results for the variable REVLINE, a proxy variable for the average price of local telephone service, are not as influential in the dominant firm - competitive fringe environment as the results from the monopoly environment. As discussed with the monopoly equations in the dominant firm - competitive fringe environment, this is consistent with both quality and competition influencing the dominant firm’s price, versus only quality influencing the monopolist’s price.
The results presented in tables 5.8 and 5.9 are consistent with the hypotheses resulting from the theory of quality in a dominant firm – competitive fringe environment. One hypothesis implied that price regulation and deregulation would not necessarily bind the firm’s quality choice in a dominant firm – competitive fringe environment. Whether the regulation is binding depends on the nature of the competitive fringe competition as well as the stringency and type of regulation imposed. The empirical results are consistent with this hypothesis. Namely, the parameter estimates have mixed signs and less statistical significance when compared to the monopoly environment, where the hypothesis indicated a clear direction of influence. Another hypothesis implied that competition could be associated with both lower and higher levels of quality. The impact of competition would depend on the nature of the competitive fringe substitutes and the stringency and type of regulation imposed. Again, the empirical results are consistent with the ambiguous hypothesis. The parameter estimates generally have mixed signs and lower levels of statistical significance than in the monopoly environment.

5.6. Additional Exogenous Variables and Local Telephone Quality

While market structure and regulation have an influence on quality-of-service, other exogenous variables could also influence a local telephone company’s quality-of-service. These exogenous variables include modern infrastructure deployment, corporate mergers, and labor unrest. Using the same panel dataset as the previous two sections, I examine whether these exogenous variables are associated with lower or higher local
telephone quality-of-service. I find that modern infrastructure deployment is associated with lower quality-of-service. There is no conclusive evidence regarding corporate mergers and quality-of-service. Finally, my results indicate no consistent relationship between labor unrest and yearly quality-of-service, although there are possible negative consequences for quality-of-service on a monthly basis from labor unrest.

5.6.1. Modern Infrastructure Deployment and Local Telephone Quality

The deployment of modern infrastructure can both be considered an indicator of local telephone quality-of-service and can influence other indicators of quality-of-service. There are several examples of local telephone modern infrastructure. These examples include digital switches, common channel signaling, fiber optic cable, and digital subscriber line (DLS) technology. The deployment of modern infrastructure is related to local telephone quality-of-service in two respects. First, the deployment of modern infrastructure is an indicator of local telephone quality-of-service. In chapter 3, my framework for local telephone quality-of-service includes equipment and system oriented service quality. The percent of the local telephone network with modern infrastructure is an objective indicator of equipment and system oriented quality-of-service in the framework. In addition, deployment of modern infrastructure can provide signals about people and process oriented service quality. By investing in modern infrastructure, the local telephone company might be signaling an overall commitment to quality. This would indicate that people and process oriented service quality should also improve.
Alternatively, by making investments in modern infrastructure, the local telephone company might be diverting resources away from investments that facilitate people and process oriented service quality. Second, deployment of modern infrastructure can directly influence people and process oriented service quality. By investing in modern infrastructure, the local telephone company can replace aging and capacity strained equipment. These investments could reduce problems that require staff repairs, make installation easier because sufficient capacity is available, and increase consumer satisfaction. Alternatively, by deploying complex systems, these investments could make installations and repairs more difficult, raise consumer expectations, and necessitate substantial staff training. Thus, it is unclear how the deployment of modern infrastructure might influence people and process oriented service quality.

To examine the impact that the deployment of modern infrastructure has on people and process oriented service quality, I study the relationship between digital stored program controlled (DSPC) switching and four quality measures. For this analysis, I use the same panel dataset as the previous analyses. The cross-section unit of analysis is the ILEC operating at the state level and the time period includes 1991 to 1999.\textsuperscript{180} Thus, the panel dataset includes 378 observations. I classify each observation based on the percent of access lines served by DSPC switches. There are four categories of observations: the first quartile (less than 61.8 percent), the second quartile (61.8 percent to 75.8 percent), the third quartile (75.9 percent to 88.2 percent), and the fourth quartile (greater than 88.2

\textsuperscript{180} As before, the analysis excludes NYNEX companies and Alaska.
percent). The first quartile consists of observations with the lowest deployment of modern infrastructure and the fourth quartile consists of observation with the highest deployment of modern infrastructure, as measured by the percent of access lines with DSPC switching.

For each category, I calculate the means and 95 percent confidence intervals for four quality measures. These measures include the percent of installation commitments met (TCOMT), total trouble reports (TTRP), repeat trouble reports (TRTRP), and total consumer complaints (TCOMP). Table 5.10 reports the results for the analysis.

<table>
<thead>
<tr>
<th>Quality Measure</th>
<th>Quartile of Digital Stored Program Control (DSPC) Switch Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Less than 61.8%</td>
</tr>
<tr>
<td>TCOMT</td>
<td>98.794 (98.616-98.972)</td>
</tr>
<tr>
<td>TTRP</td>
<td>245.2 (230.9-259.5)</td>
</tr>
<tr>
<td>TCOMP</td>
<td>0.163 (0.123-0.203)</td>
</tr>
</tbody>
</table>

Note: 95 percent confidence interval in parentheses.

Table 5.10: Mean value and 95 percent confidence interval for quality measures at quartiles of DSPC deployment.
The results in table 5.10 indicate that local telephone people and process oriented quality-of-service declines with greater levels of modern infrastructure deployment. The percent of installation commitments met declines with higher levels of access lines served by DSPC switches. For observations from the first quartile of DSPC deployment, 98.794 percent of installation commitments were met. This is higher than for observations from the fourth quartile with 98.470 percent (t=1.93). Repeat trouble reports, as a percent of total trouble reports, increased with higher levels of access lines served by DSPC switches. Repeat trouble reports were 14.999 percent of trouble reports in the first quartile of DSPC deployment. This is lower than for observations from the second quartile with 21.280 percent (t=4.05), observations from the third quartile with 22.087 percent (t=4.64), and observations from the fourth quartile with 21.681 percent (t=4.74). For consumer complaints, while complaints increase with greater levels of access lines served by DSPC switches, the results are not as statistically significant. For the first quartile of DSPC deployment, consumer complaints were 0.163 per 1,000 access lines. Consumer complaints increase to 0.290, 0.180, and 0.198 for the second, third, and fourth quartiles. However, only the second quartile is statistically different from the first quartile (t=2.09). Finally, only total trouble reports illustrates an improvement with higher levels of access lines served by DSPC switches. For observations in the first quartile of DSPC deployment, there are 245.2 trouble reports per 1,000 access lines compared to 214.7 trouble reports per 1,000 access lines in the fourth quartile of DSPC deployment (t=2.26). This result is consistent with the results presented earlier which indicate that total trouble reports are closely associated with modern infrastructure deployment and equipment and
system oriented quality. Overall, these results appear to indicate that (1) the deployment of modern infrastructure diverts resources from people and process oriented service quality or (2) the complex equipment involved in modern infrastructure imposes additional challenges for staff, or perhaps both occur simultaneously.

5.6.2. Corporate Mergers and Local Telephone Quality

Corporate mergers have resulted in a significant concentration in the local telephone industry. In 1991, there were eight local telephone companies with over 2 million access lines. These companies were NYNEX, Bell Atlantic, BellSouth, Ameritech, Southwestern Bell (SBC), US West, GTE, and Sprint/United. Through a series of mergers, there are only five local telephone companies with over 2 million access lines.\textsuperscript{181} These companies are Verizon,\textsuperscript{182} BellSouth, SBC, US West, and Sprint/United.\textsuperscript{183} Table 5.11 identifies the mergers that contributed to the concentration in the local telephone industry.

\textsuperscript{181} There are several mid-size local telephone companies including Cincinnati Bell, Citizens, and Frontier. Each of these companies has approximately 1 million access lines. The remaining local telephone companies are relatively small by comparison.

\textsuperscript{182} Verizon is the name of the company that, through a series of mergers, consists of Bell Atlantic, NYNEX, and GTE.

\textsuperscript{183} US West was purchased by Qwest Communications International, a long distance and Internet-based company. This merger did not alter the concentration in the local telephone industry.
<table>
<thead>
<tr>
<th>Acquired Company</th>
<th>Acquiring Company</th>
<th>Announcement Date</th>
<th>Approval Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific Bell</td>
<td>SBC</td>
<td>May 1996</td>
<td>May 1997</td>
</tr>
<tr>
<td>NYNEX</td>
<td>Bell Atlantic</td>
<td>April 1996</td>
<td>August 1997</td>
</tr>
<tr>
<td>SNET</td>
<td>SBC</td>
<td>January 1998</td>
<td>February 1998</td>
</tr>
<tr>
<td>Ameritech</td>
<td>SBC</td>
<td>May 1998</td>
<td>October 1999</td>
</tr>
<tr>
<td>GTE</td>
<td>Bell Atlantic</td>
<td>July 1998</td>
<td>June 2000</td>
</tr>
<tr>
<td>US West</td>
<td>Qwest</td>
<td>July 1999</td>
<td>July 2000</td>
</tr>
</tbody>
</table>


Table 5.11: Mergers in the local telephone industry.

The corporate mergers could influence the firms’ quality-of-service. While mergers increase concentration in the local telephone industry, this implication is unlikely to influence quality-of-service in a significant manner. This is because the relevant companies serve different geographic markets. Only in rare instances do the relevant companies compete directly.\(^\text{184}\) The larger impact could arise from the shifting of corporate philosophy. Some state public utility commissions argue that Ameritech’s

\(^{184}\) One condition of the SBC - Ameritech merger was that the combined company would enter local telephone markets outside its traditional geographic region.
quality-of-service has declined following the SBC merger. This could indicate that SBC’s corporate philosophy regarding quality-of-service differed from Ameritech’s and that following the merger, the SBC corporate philosophy prevailed.

To examine whether corporate mergers influence local telephone quality-of-service, I compare quality-of-service for acquired companies in the year immediately preceding and the year immediately following a merger. I assume that the merger occurs in the year when the merger is announced, when at least 6 months remain in the year. Otherwise, the merger is assumed to occur in the following year. From table 5.11, this implies that the merger years are 1996 for Pacific Bell and SBC and NYNEX and Bell Atlantic, 1998 for Southern New England Telephone Company (SNET) and SBC and Ameritech and SBC, 1999 for GTE and Bell Atlantic, and 2000 for US West and Qwest. Because of data limitations, I cannot lag the merger year beyond the announcement date or adopt the approval date. This is because most of the mergers occurred in the late 1990’s. However, in each instance, there are more than 6 months between the announcement date and the start of the posttest year. This delay allows time for the company to begin implementing corporate changes, including possible quality-of-service changes. For purposes of this analysis, I consider the Pacific Bell, SNET, and Ameritech

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185 This is a classic pretest-posttest evaluation design. Ideally, I would include a time-series element by including pretest and posttest observations for several years to control for exogenous variables. However, the available quality-of-service data is limited to a single posttest year. The 14 state-level observations help overcome some exogenous variable impact problems. Rossi and Freeman 1993 and Sylvia, Meier, and Gunn 1991.
pre- and post-merger quality-of-service.\textsuperscript{186} This leaves seven pretest and seven posttest observations. Table 5.12 reports the results, with means and 95 percent confidence intervals.

<table>
<thead>
<tr>
<th>Quality Measure</th>
<th>Pre-Merger Year</th>
<th>Post-Merger Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>98.459</td>
<td>98.760</td>
</tr>
<tr>
<td></td>
<td>(97.635-99.283)</td>
<td>(98.495-99.025)</td>
</tr>
<tr>
<td>TCOMT</td>
<td>2.760</td>
<td>2.320</td>
</tr>
<tr>
<td></td>
<td>(1.327-4.194)</td>
<td>(2.000-2.639)</td>
</tr>
<tr>
<td>AINTV</td>
<td>195.728</td>
<td>195.755</td>
</tr>
<tr>
<td></td>
<td>(165.927-225.529)</td>
<td>(167.781-223.729)</td>
</tr>
<tr>
<td>TTRP</td>
<td>0.167</td>
<td>0.185</td>
</tr>
<tr>
<td></td>
<td>(0.144-0.189)</td>
<td>(0.160-0.209)</td>
</tr>
<tr>
<td>TRTRP</td>
<td>0.150</td>
<td>0.237</td>
</tr>
<tr>
<td></td>
<td>(0.044-0.256)</td>
<td>(0.085-0.390)</td>
</tr>
<tr>
<td>TCOMP</td>
<td>5.148</td>
<td>8.040</td>
</tr>
<tr>
<td></td>
<td>(4.071-6.225)</td>
<td>(5.117-10.963)</td>
</tr>
<tr>
<td>RID</td>
<td>10.236</td>
<td>16.339</td>
</tr>
<tr>
<td>RRD</td>
<td>7.920</td>
<td>8.104</td>
</tr>
</tbody>
</table>

Note: 95 percent confidence interval in parentheses.

Table 5.12: Corporate mergers and local telephone quality-of-service.

\textsuperscript{186} I exclude GTE and US West because data do not exist for a posttest year. Also, I exclude NYNEX because of company reporting anomalies, as mentioned previously in section 5.2.
Based on the results in table 5.12, no definitive conclusions can be drawn regarding corporate mergers and quality-of-service. Of eight quality measures, six are consistent with lower quality-of-service in the year following a merger compared to the year preceding the merger. These six measures are total trouble reports, total repeat trouble reports, total consumer complaints, and residential dissatisfaction with installation, repair, and business office service. The two measures with improved quality-of-service are associated with installation services, total commitments met and average installation interval. However, the difference between the pretest and posttest year is only statistically significant for residential dissatisfaction with repair service. Residential consumers are more dissatisfied with repair service following a corporate merger than before (t=2.91). Thus, no convincing evidence exists regarding the impact of corporate mergers on quality-of-service.

5.6.3. Labor Unrest and Local Telephone Quality

By definition, people and process oriented service quality depends on the company’s workforce. To fulfill consumers’ needs, it is necessary for the company to employ and train a sufficient number of workers. Labor unrest, particularly in the form of a strike, can significantly reduce the number of staff resources and can make the remaining staff less effective. During a strike, staff positions are often filled by management and
temporary employees. These employees generally lack the skills of striking employees and are often insufficient in number to fully replace striking employees. Thus, a testable hypothesis is whether strikes are associated with lower quality-of-service.

During the 1991 to 1999 period, labor relations in the local telephone industry were generally stable. There were three strikes during this period, all which occurred in 1998. ¹⁸⁷ US West and SNET were the targets of approximately three-week strikes in 1998. Bell Atlantic was the target of a two-day strike also in 1998. There are two major unions that organize labor in the local telephone industry. The International Brotherhood of Electrical Workers represents many local telephone employees involved with installation and repair services. The Communications Workers of America represents a broad array of local telephone employees, including those involved with directory and operator services. Thus, a strike by either or both of these two unions will directly influence consumer service.

To examine whether a strike influences a local telephone company’s quality-of-service, I compare quality-of-service in a strike year with the quality-of-service one year prior to and one year after the strike for eight quality measures. ¹⁸⁸ I include the US West and SNET 1998 strikes; this provides 15 state-level observations. I exclude the Bell

¹⁸⁷ In 1989, there was widespread labor unrest in the local telephone industry. NYNEX, Bell Atlantic, and Pacific Telesis were the targets of strikes in 1989 that affected directory and operator services (McFadden 1989). In 2000, Verizon, a company formed by the mergers of Bell Atlantic, NYNEX, and GTE, was subject to a three-week strike that resulted in significant consumer disruptions in installation and repair services (Dreazen 2000).

¹⁸⁸ This is another classic pretest - posttest evaluation design. Because both strikes occurred in 1998, I am limited to a single posttest year. This data limitation does not allow the time-series element that helps mitigate the influence of exogenous variables. However, the 15 state-level observations help overcome the exogenous variable problem somewhat. Rossi and Freeman 1993 and Sylvia, Meier, and Gunn 1991.
Atlantic 1998 strike because of the limited duration. To uncover any month-to-month variations, I examine state-level monthly data from Oregon, a state served by US West. Table 5.13 illustrates the results, means and 95 percent confidence intervals, for the 15 state-level observations for the US West and SNET strikes.

<table>
<thead>
<tr>
<th>Quality Measure</th>
<th>Pre-Strike Year</th>
<th>Strike Year</th>
<th>Post-Strike Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCOMT</td>
<td>98.061 (97.519-98.602)</td>
<td>98.115 (97.519-98.711)</td>
<td>98.419 (98.182-98.655)</td>
</tr>
<tr>
<td>AINTV</td>
<td>1.321 (0.630-2.012)</td>
<td>1.636 (0.885-2.387)</td>
<td>1.457 (1.067-1.847)</td>
</tr>
<tr>
<td>TTRP</td>
<td>182.592 (169.890-195.293)</td>
<td>185.483 (170.887-200.079)</td>
<td>184.343 (166.434-202.251)</td>
</tr>
<tr>
<td>TRTRP</td>
<td>0.308 (0.285-0.331)</td>
<td>0.325 (0.299-0.351)</td>
<td>0.343 (0.313-0.372)</td>
</tr>
<tr>
<td>TCOMP</td>
<td>0.373 (0.215-0.532)</td>
<td>0.494 (0.317-0.671)</td>
<td>0.653 (0.379-0.928)</td>
</tr>
<tr>
<td>RID</td>
<td>4.412 (3.360-5.464)</td>
<td>4.700 (3.418-5.982)</td>
<td>6.735 (5.127-8.342)</td>
</tr>
<tr>
<td>RBOD</td>
<td>1.888 (1.428-2.348)</td>
<td>2.091 (1.537-2.644)</td>
<td>2.965 (1.742-4.188)</td>
</tr>
</tbody>
</table>

Note: 95 percent confidence interval in parentheses.

Table 5.13: Strikes and local telephone quality-of-service.
The results in table 5.13 indicate that strikes do not result in lower local telephone quality-of-service. First, compare the pre-strike year and strike year. Of the eight quality measures, only total commitments met showed improved quality during the strike year while seven measures showed lower quality during the strike year. However, none of the differences were statistically significant. Second, compare the strike year and the post-strike year. Five measures showed improved quality during the strike year while three showed lower quality. However, only the result for residential consumer dissatisfaction with repair services was statistically significant (t=2.17). These results appear to indicate that strikes do not influence local telephone quality-of-service. However, the most likely reason for these results is the relatively short duration of the strikes considered in the analysis. Even at three weeks, the strikes considered only disrupted company operations for less than 6 percent of the year. Thus, the impact of the strike could be overshadowed by the activities during the remaining 49 weeks.

State-level data reported monthly perhaps will better identify the impact of a strike on local telephone quality-of-service. The Public Utility Commission of Oregon reports data on open investigations on a monthly basis (Public Utility Commission of Oregon 2000). Open investigations are commission reviews of consumer complaints that have not been resolved by the end of the month. Thus, open investigations are a proxy for consumer complaints. In the three months prior to the strike against US West in 1998, there were an average of 500 open investigations at the end of the month. During the month of the strike, open investigations increase to approximately 1,200. Thus, during the
month of the strike, open investigations more than doubled. This would indicate that a strike has significant short-term impact on quality-of-service. However, averaged over the entire year’s activities, strikes are less significant.
CHAPTER 6

CONCLUSION

The theoretical and empirical findings in this dissertation support the hypothesis that quality will differ in monopoly and dominant firm - competitive fringe market structures. In the monopoly environment, the evidence indicates that regulation will directly impact firm quality. However, with the introduction of a competitive fringe, the outcome depends on several variables, including the type and stringency of regulation, the amount of competition, and the nature of the competition. In this dissertation, I make four theoretical and empirical contributions. I develop a framework of quality for the local telephone industry. I extend the existing theoretical literature on monopoly, quality, and regulation and develop a theory of quality in the dominant firm - competitive fringe environment. Finally, I perform a comprehensive empirical analysis of local telephone quality-of-service. In addition to the theoretical and empirical contributions, I also provide insights for regulators. Regulators should benefit from the analysis of monopoly and quality with regulation, the change in quality associated with the transition to a dominant firm - competitive fringe environment, and the impact of regulation on quality in a dominant firm - competitive fringe environment.
6.1. Summary of Findings

In this dissertation, I examine quality in two distinct market structures, the monopoly and dominant firm - competitive fringe market structures. A major hypothesis is that the incentives to provide quality are different in the monopoly and dominant firm - competitive fringe market structures. The theoretical and empirical analyses support this hypothesis. The results are relatively well defined in the monopoly environment. However, in the dominant firm - competitive fringe environment, the results are case specific.

In a monopoly environment, I find that regulation will directly influence a monopolist’s quality. In the theoretical analysis, the specific outcome depends on the type of regulation and nature of demand. When the inframarginal consumers’ willingness to pay for quality exceeds the marginal consumer’s willingness to pay for quality and demand is inelastic (i.e., \( \pi_{pq} > 0 \)), I find that price regulation will result in lower quality while rate-of-return and quality regulation will result in higher quality compared to the unregulated monopolist’s quality. Alternatively, when the marginal consumer’s willingness to pay for quality exceeds the inframarginal consumers’ willingness to pay for quality (i.e., \( \pi_{pq} < 0 \)), quality improves with price, quality, price and quality, and rate-of-return regulation. The local telephone industry is most consistent with inframarginal consumers’ willingness to pay for quality exceeding the marginal consumer’s willingness to pay for quality and inelastic demand (i.e., \( \pi_{pq} > 0 \)). In the empirical analysis, regression results for the local
telephone industry confirm the theoretical predictions. Among the four quality measures considered, price cap/rate freeze regulation and deregulation are associated with lower quality-of-service for three measures compared to rate-of-return regulation. The sole outlier is associated with equipment and system oriented quality.\textsuperscript{189} Thus, the theoretical and empirical results provide a consistent message regarding regulation.

In the dominant firm - competitive fringe environment, I find mixed results for the dominant firm’s quality. In the theoretical analysis, I find that the specific outcome depends on (1) the nature of the competitors’ substitute products or services, (2) the amount of competition, and (3) the nature and stringency of the regulation. These three factors combine to determine whether competition, regulation, or both influence the dominant firm’s quality. In the unregulated dominant firm - competitive fringe environment, the presence of a low quality substitute induces the firm to improve quality vis-à-vis the monopolist. However, the dominant firm’s quality is lower than the monopolist when a high quality substitute is present and the results are unclear when both low and high quality substitutes are present. In the regulated dominant firm - competitive fringe environment, the results are more ambiguous. With price regulation, the dominant firm’s quality declines vis-à-vis the unregulated position with a low quality substitute while the outcome is uncertain with a high quality substitute. With quality regulation, the dominant firm’s quality improves vis-à-vis the unregulated position with a high quality substitute while the outcome is uncertain with a low quality substitute. Finally, with rate-\underline{ }\underline{ }

\textsuperscript{189} The presence of the outlier illustrates the importance of the framework of quality presented in chapter 3 that incorporates the distinction between equipment and system oriented quality and people and process oriented quality.
of-return regulation, the dominant firm's quality improves vis-à-vis the unregulated position with a high quality substitute while the outcome is uncertain with a low quality substitute.

In the empirical analysis, regression results mirror the uncertainty in the theoretical analysis concerning a dominant firm's quality. First, when applying the monopoly regression equations to observations in a dominant firm - competitive fringe environment, I find mixed results. Price cap/rate freeze regulation and deregulation are associated with improved quality for two measures and lower quality for two measures. This differs from the monopoly environment. This result lends support to the notion that the incentives to provide quality are different in the monopoly and dominant firm - competitive fringe environments. Second, with the dominant firm - competitive fringe regression equations, I find mixed results for both the competition and regulation variables. In this analysis, I considered eight quality measures. Increased competition is associated with improved quality-of-service for three measures and lower quality-of-service for five measures. Additionally, price cap/rate freeze regulation and deregulation are associated with improved quality-of-service for four measures and lower quality-of-service for four measures. Thus, the empirical results provide support to the hypothesis that the impact of competition and regulation will be mixed in the dominant firm - competitive fringe market structure.
6.2. Theoretical and Empirical Contributions

In this dissertation, I make four theoretical and empirical contributions. First, I develop a framework of quality for the local telephone industry. The framework that I develop permits theoretical and empirical analyses of quality in the local telephone industry. Second, I extend the existing theoretical literature on monopoly and quality. In price-quality space, I show how public utility regulation will influence a monopolist’s quality. Third, I develop a theory of quality for the dominant firm - competitive fringe environment, also incorporating regulation. This analysis fills a void in the existing theoretical literature between monopoly and quality and oligopoly and quality. Finally, I perform a comprehensive empirical analysis of local telephone quality-of-service.

In chapter 3, I develop a framework of quality for the local telephone industry. Richters and Dvorak (1988) propose a comprehensive framework of quality for the local telephone industry. The authors’ framework consists of seven communications functions and seven performance criteria. With the framework, companies and regulators can establish standards and monitor performance. Oodan, Ward, and Mullee (1997) extend the Richters and Dvorak framework. However, I argue that neither framework is appropriate for a theoretical or empirical analysis of quality in the local telephone industry. This is because neither framework distinguishes between (1) equipment and system oriented quality and (2) people and process oriented quality. I argue that equipment and system oriented quality is closely aligned with the investment in infrastructure. A well established literature addresses the firm’s incentive to invest in infrastructure (e.g., Spence
1977, Dixit 1980, and Fudenberg and Tirole 1984). I argue that people and process oriented quality is closely aligned with short-term investments. This is the subject of the theoretical and empirical portion of this dissertation and the work of Spence (1975), Sheshinski (1976), Vander Weide and Zalkind (1981), Shaked and Sutton (1982), and Cook (1993). Without this distinction, the theoretical and empirical analyses will be incomplete. For example, with an understanding of this distinction, the divergent empirical results for total trouble reports are understandable given the close relationship between total trouble reports and investment in modern infrastructure.

The framework of quality that I propose makes this distinction, as well as incorporates concepts from the major paradigms that address quality. First, my framework distinguishes between equipment and system oriented quality and people and process oriented quality. This permits a comprehensive analysis of local telephone quality-of-service. Second, my framework distinguishes between objective and subjective measures of quality. The economics-based and operations research-based paradigms conceive of quality as an objective measure. Alternatively, the marketing-based paradigm focuses on the subjective elements of quality. By considering both the objective and subjective measures of quality, my framework incorporates elements from all the major paradigms.

In chapter 4, I extend the existing literature on monopoly, quality, and regulation. Spence (1975), Sheshinski (1976), and Mussa and Rosen (1978) provide insights on how a monopolist’s supply of quality will deviate from the level that maximizes social welfare. These authors show that monopoly supply creates both efficiency and equity distortions.
Efficiency distortions arise from the over or under supply of quality while equity
distortions arise from the monopolist's desire to sort consumers by their willingness to pay
for quality. My research extends this literature into the common regulatory environments
encountered in the local telephone industry. These regulatory environments include (1)
price regulation, (2) quality regulation, (3) price and quality regulation, and (4) rate-of-
return regulation. In price-quality space, I show how a monopolist's quality will differ
between the unregulated position, which corresponds to a deregulatory environment, and
each of the four regulatory environments. Further, I argue that hypotheses developed for
the monopoly environment will not necessarily hold in the dominant firm-competitive
fringe environment. An appropriate analysis of quality in the transition underway in the
local telephone industry requires a comparison of both the monopoly and dominant firm-
competitive fringe environments.

To accomplish this comparison, I develop a theory of quality in the dominant firm-
competitive fringe environment. According to Chessler (1996), "there have been no
systematic studies of the relationship between the level of quality and the degree of
competition." The existing literature that addresses quality only considers the
monopoly, duopoly and oligopoly, and competitive market structures. However, this
literature does not explain quality in several important industries of the American
economy. In particular, the public utility industries; including electric, natural gas, and
local telephone; exhibit the dominant firm-competitive fringe market structure. The

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190 Chessler (1996), 14.
dominant firm - competitive fringe market structure consists of a single large firm, the
dominant firm, and a group of small firms, the competitive fringe. The recent literature on
the dominant firm - competitive fringe market structure extends the basic model to include
regulation (e.g., Abel 1999). However, no one has incorporated quality or quality and
regulation into the dominant firm - competitive fringe model.

My analysis of quality in the dominant firm - competitive fringe environment fills
this void in the literature. I fill a void in the quality and market structure literature. I also
extend the dominant firm - competitive fringe model. My analysis addresses dominant
firm quality as influenced by (1) the nature of the competitive fringe competition and
substitutes and (2) regulation. The theory that I develop permits an explanation of the
change in quality from the monopoly environment to the dominant firm - competitive
fringe environment and the impact that regulation could have on quality in the dominant
firm - competitive fringe environment. These issues are not addressed in the current
literature.

In chapter 5, I perform a comprehensive analysis of local telephone quality-of-
service. First, I develop a comprehensive panel dataset. The dataset consists of
observations for the largest local telephone company in each state and the District of
Columbia, excluding Alaska, for the nine year period 1991 to 1999. Additionally, I
incorporate eight quality measures. These measures include both objective and subjective
measures consistent with my framework of quality. Second, I incorporate the different
incentives created by the monopoly and the dominant firm - competitive fringe market
structures. Other authors (e.g., Ai and Sappington 1998 and Roycroft and Garcia-Murriilo

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2000) make no distinction and commingle observations from the monopoly and the
dominant firm - competitive fringe market structures. This can influence the parameter
estimates for the regulation and competition variables. Finally, my empirical framework
addresses many of the “potential pitfalls” identified by Sappington and Weisman (1996)
for empirical analysis of alternation regulation regimes. The comprehensive panel dataset
helps mitigate the “measurement timing pitfall”\textsuperscript{191} and the “causality pitfall.” The
structural equations that motivated the regression analysis also help mitigate the “causality
pitfall.” The separate regression analyses for the monopoly and dominant firm -
competitive fringe market structures help mitigate the “competition effect pitfall.”\textsuperscript{193}
Finally, by including the quality regulation variable, I address the “mandated versus
motivated pitfall.”\textsuperscript{194} Thus, my empirical framework addresses many of the problems cited
in the literature that plague current empirical research in the telecommunications area.

\textsuperscript{191} The “measurement timing pitfall” occurs when the time period under consideration is less than ideal
(e.g., the time period is too short or does not cover a period when the relevant change occurred).

\textsuperscript{192} The “causality pitfall” arises when causality is confused with correlation.

\textsuperscript{193} The “competition effect pitfall” occurs when the observed effects are attributed to the alternative
regulation when some or all the observed effects are the result of competition.

\textsuperscript{194} The “mandated versus motivated pitfall” arises when the observed effects are attributed to the
motivational impact of alternative regulation when the effects are actually mandated by regulation.

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6.3. Policy Implications of Research

Regulators, especially those at state public utility commissions, face the daunting challenge of managing an industry transition while fulfilling a long-standing obligation to maintain and improve quality. A transition in market structure and regulation is underway in the local telephone industry. Encouraged by the Telecommunications Act of 1996, competition is emerging in local telephone markets. However, the markets remain dominated by incumbent local exchange carriers (ILEC). This suggests that a dominant firm - competitive fringe market structure is replacing the long-standing monopoly market structure. Also, the regulatory regime of choice is changing from rate-of-return regulation to various alternative regulation regimes, including price cap and rate freeze regulation. These changes pose challenges for regulators. At the same time, regulators must continue to fulfill their long-standing obligation to maintain and improve quality. Quality-of-service is becoming increasingly important as society relies more and more on the telephone industry for commerce. Poor quality-of-service will hamper commerce that increasingly relies on the Internet and other data intensive activities. In this dissertation, I provide insights that will assist regulators in maintaining and improving quality as they manage the transition from a monopoly and rate-of-return regulation environment to a competitive and alternative regulation environment.

195 While rates have been traditionally the most important focus for state public utility commissions, regulators cannot ignore the relationship between rates and quality-of-service. "[T]here is no such thing as a reasonable rate for service that is deficient." Phillips (1993), 553.
In this dissertation, I provide guidance to regulators about quality in monopoly markets. Some markets are likely to remain subject to monopoly supply for some time. These markets are served by smaller ILECs and ILECs in rural areas. Thus, regulators in states with small, rural ILECs can benefit from guidance about quality in monopoly markets. Sections 4.1 and 5.4 provide theoretical and empirical evidence about quality in monopoly markets with regulation. Price regulation (e.g., price cap and rate freeze) and deregulation are associated with lower quality-of-service than is rate-of-return regulation. Many small, rural ILECs remain subject to rate-of-return regulation. However, I suggest that any movement towards price regulation or deregulation for these companies could lead to lower quality-of-service. Based on the theoretical analysis, price regulation combined with quality regulation appears to mitigate the lower quality-of-service.

With many markets experiencing competitive entry, the insights that I provide in this dissertation about quality in a dominant firm - competitive fringe market compared to a monopoly market should prove valuable to regulators. Many local telephone markets are experiencing competitive entry. Initially, the competitive entry is concentrated in urban areas. As competitive entry continues, it is critical for regulators to understand how quality could change. Section 4.2.3 provides a theoretical analysis of quality in a dominant firm - competitive fringe environment. Whether the dominant firm’s quality improves or worsens depends on the amount of competition and the nature of the competitors’ service. If competitors enter with a low price, low quality substitute (e.g., a discount service), the dominant firm will likely improve its quality. The opposite is likely to occur if the
competitors enter with a high price, high quality substitute (e.g., a premium service).

Since most consumers will remain with the dominant firm, these insights are important as
regulators continue to promote the public interest though their obligation to quality.

In this dissertation, I also provide insights on the impact of regulation in the
dominant firm - competitive fringe environment. Many state public utility commissions
continue with regulations established in the monopoly environment. A critical question is
whether the regulation imposed in the monopoly environment continues to have the same
desired effect in the dominant firm - competitive fringe environment. The theoretical and
empirical analyses indicate that the specific outcome will be case specific. For each type
of regulation, whether the regulation remains effective depends on (1) the stringency of
the regulation, (2) the amount of competition, and (3) the nature of the competition (e.g.,
low or high quality substitutes). This is an important insight for regulators. Regulators
must reevaluate their rate and quality regulation in light of the competition occurring in
their particular markets.

The final contribution, and a topic for future research, concerns companies’
resource allocation to quality. The framework of quality for the local telephone industry
presented in chapter 3 identified two types of quality. These are the equipment and system
oriented quality and people and process oriented quality. In this dissertation, I focus on
people and process oriented quality. However, the evidence suggests that there are
differences between the two types of quality. For example, total trouble reports, which
was shown to be closely associated with equipment and system oriented quality,
responded differently to regulation and competition than the other, people and process
oriented, quality measures. Thus, understanding these differences could prove helpful to regulators. Competition or regulation could affect the two types of quality differently. A topic for future research concerns how companies shift resources between equipment and system oriented quality and people and process oriented quality in response to competition and regulation. This would further the understanding of quality, broadly defined, in various market structures and regulatory environments.

In summary, the evidence from this dissertation addresses the issues presented in the introduction. The local telephone industry is in transition. The transition is affecting both regulation and market structure. At the same time, quality is important and becoming more so. In a strategic industry such as local telephone, the benefits to society depend on quality-of-service. In this dissertation, I provide theoretical and empirical evidence that both fills a void in the literature and helps regulators and policy makers address quality-of-service in a transitional market.
BIBLIOGRAPHY


