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DEREGULATION IN THE POST-DIVESTITURE
LONG-DISTANCE TELECOMMUNICATIONS MARKETS

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DEREGULATION IN THE POST-DIVESTITURE LONG-DISTANCE TELECOMMUNICATIONS MARKETS

By

David Eugene Burnstein

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ABSTRACT

DEREGULATION IN THE POST-DIVESTITURE LONG-DISTANCE TELECOMMUNICATIONS MARKETS

By

David Eugene Burnstein

Following the 1984 divestiture, state and federal regulators implemented a variety of (de)regulatory policies to facilitate the transition to a market environment. In the first two essays, presented in chapters two and three, I discuss the *effects* of these policies on the inter- and intrastate long-distance markets' performance, respectively. The final essay, presented in chapter four, examines the *causes* of rate deregulation in the intrastate markets.

The principal results of the interstate study are the following: First, the steep decline in access fees and development of "equal access" technology were responsible for a significant portion of the decline in interstate prices. The equal access policy was also responsible for a substantial decline in the carriers' market power. Second, the Federal Communications Commission's implementation of price-cap regulation had an economic and statistically insignificant impact on carriers' prices and market power. Third, the subsequent rate deregulation of AT&T's domestic interstate services contributed to the recent increase in the carriers' prices and restored some of their market power. Finally, the estimates of AT&T and its competitors' Lerner indices of market power were 0.64 and 0.34, respectively. These results suggest the carriers still possess significant market power.

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The intrastate study reached similar conclusions as the preceding interstate study. First, implementation of rate deregulation reduced carrier "competitiveness" producing a 5 percent increase in the market price. Second, an increase in the number of facility-based long-distance carriers competing in a state had the perverse effect of reducing carrier competitiveness and generating an 8 percent increase in the market price. Third, in those states that deregulated entry to the adjacent *intraLATA* toll market, the competitiveness of *interLATA* market conduct diminished, resulting in a 5 percent increase in the *interLATA* market price.

The general objective of the final essay is to ascertain political and economic characteristics of a state that were conducive to the implementation of rate deregulation. Based on a private interest theory of economic regulation the study uncovered the following: First, the intensity of business interests, measured as the percentage of business to total local access lines, was positively correlated with the probability of rate deregulation. Second, the prior employment characteristics of the regulators was a significant factor in the selection of rate deregulation, that is, the probability of rate deregulation decreased with the percentage of commissioners previously employed as (residential) consumer advocates and increased with the percentage of commissioners previously employed as senior level business managers or owners. Finally, two tests were conducted for (*i*) the presence of regulator slack and (*ii*) a "demonstration effect." The former tested for the product of slack, or "shirking" activity, while the latter examined the regulated firm price setting behavior for a strategic component. The results of the tests were unable to reject shirking and strategic firm behavior as influential factors.

To Stephanie, whose love, strong support, motivation, warmth, and ability to leap small buildings in a single bound create a partnership with the freedom of spirit to explore, grow, and achieve.

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Last and most important, I acknowledge and offer heartfelt thanks to Eugene and Martha Kathryn Burnstein. They have the rare ability as parents to provide unconditional love and an unwaning expectation that you will accomplish as professionals and as people. In many moments and in many ways, they have been my inspiration.

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Chapter One

The Post-Divestiture Long-Distance Market Environment: Introduction and Overview

The 1982 Modified Final Judgment (MFJ) - which resolved an antitrust suit filed by the Department of Justice in 1974 and formed the basis for the January 1, 1984 divestiture of AT&T - allowed AT&T to keep its long-distance operations, manufacturing operation, and research and development facility. However, the judgment required AT&T to divest its monopoly local exchange business by spinning off its Bell Operating Companies. In return, AT&T was permitted to enter businesses beyond common carrier services, such as the computer industry, which it had been prohibited from doing previously. The seven independent Regional Bell Operating Companies (RBOCs), created from the Judgment, were to provide local exchange services to the end-customer as well as provide exchange access to the long-distance interexchange carriers (IXCs). The restrictions placed on the RBOCs were as follows: (*i*) they were forbidden from providing interlata long-distance service; (*ii*) they could not manufacture equipment; and (*iii*) they could not provide information services.[1]

In addition to this dramatic industry-wide restructuring, five developments specific to the long-distance markets transpired concurrent or subsequent to divestiture: (*i*) the implementation of "equal access" technology, (*ii*) non-regulated entry to the long

[1] LATA, short for Local Access and Transport Area, is a geographic entity created at the time of divestiture as the demarcation boundary for the RBOCs. Calls which cross the LATA boundary, interLATA calls, must be passed off to a long distance company. IntraLATA calls do not cross a LATA boundary and, thus, are typically transmitted end-to-end by the RBOC.

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distance markets, (*iii*) rate restructuring, (*iv*) incremental rate deregulation, and (*v*) the expansion of fiber optic transmission technology.

First, a provision in the Judgment required the RBOCs to provide all long-distance carriers with "equal access." This provision enabled a customer to make a non-AT&T toll call without dialing several extraneous numbers to connect to his preferred IXC. Therefore, once an RBOC had implemented equal access, a customer could choose among the available IXCs by simply presubscribing to his preferred carrier.

Second, during the period of divestiture both state and federal regulators were eliminating virtually all regulatory barriers into long-distance markets. That is, entry into the market only required filing an application with the appropriate state Public Service Commission (PSC) and the Federal Communications Commission (FCC), with "virtually every application for entry being approved."[2]

Third, in compliance with the MFJ, the FCC began rebalancing local and toll prices primarily through two related activities. The first pertains to the FCC's 1984 access charge ruling which mandated a fundamental change in RBOC access charges. The outcome was a substantial decline in the access fees paid by IXCs and the application of an access fee to the final consumer via a "subscriber line charge."[3] The second pertains to a series of accounting changes instituted by the FCC which shifted a portion of the local exchanges' fixed costs from interstate to intrastate telephone service. The rebalancing of rates was concluded in 1992, when the FCC stopped requiring AT&T to pass on access fee reductions to its customers.

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[2] See Kaserman and Mayo (1994), p.89.

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[3] See *MTS*
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Fourth, while incremental changes in the rate regulation of intrastate long-distance service followed divestiture, wide-spread rate deregulation has transpired in both the intra- and interstate markets in more recent years. For example, between 1984-89, 28 of the 38 multi-LATA states eliminated traditional rate-of-return regulation, with the majority of these states choosing a pricing-flexibility regulatory policy (e.g., price-cap regulation, banded rate-of-return regulation, moratorium regulation, etc.)[4] and just a few states choosing rate deregulation. In contrast, subsequent to 1989 the pool of rate deregulated states has expanded dramatically, while the number of pricing-flexibility regulated states has declined. As of present all states have ceased imposing traditional rate-of-return regulation. In the interstate market, the FCC replaced rate-of-return regulation with price-cap regulation in July 1989. The FCC granted AT&T's request to be reclassified as a "non-dominant" common carrier in October 1995. The outcome was the deregulation of domestic rates for interstate long-distance service.[5]

Finally, the rapid development and expansion of fiber optic technology dramatically altered the method of long-distance transmission. At the time of divestiture it was believed that long-distance carriers would compete against each other using microwave technology. Since microwave transmission does not entail large sunk costs and requires minimal traffic before it reaches diminishing returns to scale, it was concluded that the long-distance market was not a natural monopoly. Hence, it was

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[3] See *MTS and WATS Market-Structure*, Third Report and Order, CC Dkt. No. 78-72, 93 F.C.C. 2d 241, 251,252.

[4] See Kridel, Sappington, and Weisman (1996), pp. 271-274, for a detailed description of pricing-flexibility regulatory policies.

[5] See *Motion of AT&T Corp. to be Reclassified as a Non-Dominant Carrier*, 11 FCC Rcd 3271, 3288, ¶26 (1995). The FCC still imposes rate averaging based on time of day, distance and duration. In addition, price-cap regulation is still maintained in the international telecommunications market.

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microwave radio technology that was an impetus to the deregulation of the long-distance market. "But even as the ink was drying on the divestiture decree, long-distance companies were dynamiting their microwave towers to the ground, replacing them with fiber-optic glass."[6] The rise of fiber optic cable as the dominant technology for the transmission of interexchange services dramatically changed the cost structure of the long-distance market. The labor and capital required to construct a nationwide fiber network was substantial and the acquisition of the necessary rights of way was legally cumbersome. The incremental costs of installing cable with additional optical fibers was minimal, yet the incremental benefit from increased capacity was potentially large. Thus, it was considered efficient to lay the groundwork for an optical fiber network, in which large segments were initially dark, and as the market developed the segments would be lit up as needed.[7] Lastly, once a network was built it had few alternative uses (i.e., its salvage value was close to zero).[8] Therefore, the long-distance infrastructure composed of fiber optic glass is structurally quite different than a microwave based network.

The implementation and expansion of equal access, non-regulated entry, rate restructuring and deregulation, and fiber optic technology were important structural adjustments that significantly altered the long-distance market environment. According to Lawrence Garfinkel, AT&T's former vice president of public affairs, these post-divestiture developments were "unprecedented events in business history: All of the

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[6] See Huber (1993a), p.A10.
[7] "Dark" and "lit" are industry terms used to distinguish between portions of the fiber network that are connected to functioning electronics ("lit"), and portions of the network not in use ("dark").
[8] See Huber (1993b), p.36. For an argument contesting the claim that fiber optic networks are a barrier to entry see Kaserman and Mayo (1994), p.90.

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business in a mature market has suddenly been thrown up for grabs."[9] In his written opinion, Judge Harold Greene stated that the fundamental objective of the MFJ was to "establish the foundation for a truly competitive telecommunications industry...with the removal of these barriers to competition, AT&T should be unable to engage in monopoly pricing in any market."[10] Five years later, Judge Greene again concluded "that competition now exists in the interexchange market, and that the entry of the Regional [Bell Operating] Companies into that market is not necessary to give it vitality."[11] Peter Huber, the author of the Department of Justice's 1987 review of the MFJ, confirmed that "If one is to judge by installed transmission capacity, competition in the interLATA markets is healthy...[and] in many large urban markets apparently remains vigorous."[12]

During much of the post-divestiture period, statements hailing the burgeoning competition in the long-distance market were solidly supported by the statistical profile of the industry. For example, not only were AT&T's long distance rates reduced about 45% in real terms between 1984 and 1991, but the company's share of the long-distance market dropped from 84.2% in 1984 to 62.9% in 1990 as well. Demand for switched access minutes grew 111% from 37.5 billion in 1984 to 79.1 billion in 1991. While AT&T's volume increased by 58%, that of its competitors rose almost 400% during this same time frame.[13]

Unfortunately, this apparent trend towards a competitive long-distance market has recently shown signs of regression. For example, in 1992, while access fees continued to

[9] See Garfinkel (1993), p.325.
[10] United States v. AT&T, 48 PUR 4th 227, 552 F.Supp. at 172 (D.D.C. 1982).
[11] 673 F. Supp. at 550.
[12] See Huber (1987), p.3.2.
[13] These statistics were taken from Noam (1992), p.443.

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decline, the basic rate for residential interstate telephone service increased for the first time since divestiture and has continued to increase in each subsequent year. This development has given support to those asserting that the long-distance market is not evolving towards a competitive market, but is instead "a stable oligopoly, propped up by regulation, and operating under an AT&T-supplied canopy of umbrella pricing."[14] In particular, it is argued that the decline in AT&T's market share and the price of long-distance service are largely the result of regulatory mandate. For example, Taylor and Taylor (1993) indicate that the overall reduction in interstate long-distance prices was more than explained by the reduction in the carrier access charges paid by the long-distance carriers to the local telephone companies. Likewise, in an attempt to make the other common carrier's (OCC's) "non-premium" interLATA service competitive with AT&T's "premium" service, the FCC mandated a 45% reduction in non-premium access fees.[15] It is held that this disparity in access fees more than compensated the OCC's for the lower quality service they provided. In fact, the higher access charges that AT&T was mandated to pay, in effect, raised its costs relative to those of the other large carriers and set in place conditions that forced shifts away from AT&T in market share.[16]

Therefore, given the post-divestiture regulation of the long-distance telecommunications market, it is not unusual to see dramatic changes in the market's structure. However, after taking into account the impact of these new policies, it is

[14] See Huber (1992), p.1.15.

[15] "Premium" and "non-premium" access are used to describe the type of access that a customer has to the long distance network. Premium access, often referred to as "1+" service only requires the customer to dial 1+ the phone number of its desired destination. Non-premium access requires a customer to dial a separate number to contact his long-distance provider, enter an identification number and then dial the number of the desired destination.

[16] See MacAvoy (1995), p.152.

argued that the long-distance market is not evolving towards a competitive market, but instead is becoming a natural monopoly with significant barriers to entry. Peter Huber, who in 1987 was a proponent of "vigorous" long-distance competition, cogently restated his position in a 1993 *Regulation* article:

> Despite all the hype from Candice Bergen, the long-distance industry is now characterized by umbrella pricing, under a canopy maintained by FCC regulation and AT&T. AT&T is ostensibly subject to 'price cap' regulation by the FCC, but the cap is really a floor. The Commission spends most of its time making sure that AT&T does not lower its prices too fast; competitors rush to court whenever AT&T's prices seem likely to fall...Under careful FCC supervision, AT&T pays off MCI and Sprint in market share and subsidized local access, in return for which they shield AT&T from the government. The payoff may seem high - $8 billion a year to MCI alone - but it protects AT&T's $53 billion in assets and $63 billion in annual revenues from further predation by lawyers. No insider is going to be crazy enough to disrupt this cozy little arrangement. What we have here is umbrella-priced oligopoly, in which everyone is kept calm by the combined wisdom of one market leader and an acquiescent federal commission.[17]

The chapters that follow attempt to contribute empirical evidence on the *effects* (in chapters 2 and 3) and *causes* (in chapter 4) of post-divestiture deregulation in the intra- and interstate long-distance markets. Each of the three chapters are self-contained essays that stand on their own. Taken together, however, they paint an interesting picture on the successes and failures of economic regulation. Before proceeding the objective of each chapter is briefly outlined below.

Chapters two and three examine the impact of regulatory change on the long-distance carriers' prices and market power. This is accomplished by implementing static oligopoly models that nest various types of firm and market conduct. In both chapters the data is disaggregated into time-period subsamples based on the occurrence of

[17] See Huber (1993b), p.38.

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hypothesized changes in the market structure. More specifically, the data is tested for variation in the firm and market conduct variables in response to changes in the regulatory environment. Chapter two examines firm level time-series data on the interstate market, while chapter three examines state level panel data on 36 intrastate markets.

Finally, chapter four examines the influence of a variety of economic and political variables on the probability that a state chooses to implement rate deregulation. Two issues are given particular attention. First, I test for the presence of strategic firm behavior in a pricing-flexibility regulatory environment. This requires that the regulatory policy and the regulated price be recognized as endogenous to the model of regulatory change. A simultaneous (OLS-Logit) system based on a private interest theory of economic regulation is specified. Second, I test for the presence of political slack, as suggested by Kalt and Zupan (1984). In doing so, I include a vector of variables in the logit equation that control for the cost of (slack induced) regulator "shirking" and examine the model's response to the inclusion of these variables.

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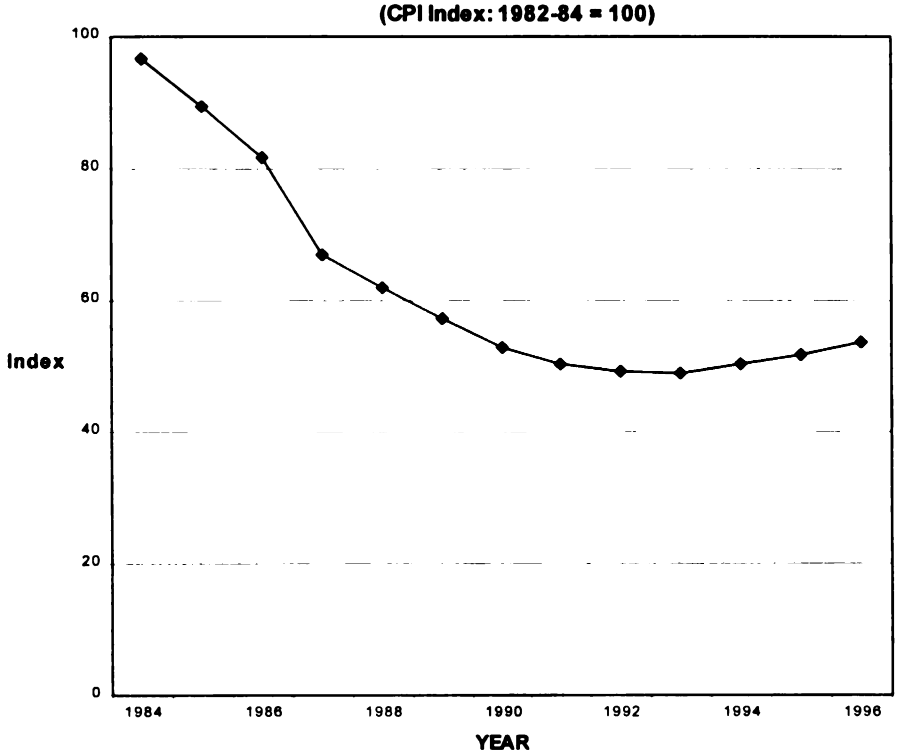
Chapter Two

Regulatory Change and Its Impact on Long-Distance Prices and Market Power: The Interstate Market

2.1 Introduction

While there has been a substantial overall decline in the prices of interstate long-distance service since 1984, in recent years these prices have demonstrated a gradual but consistent upward trend (see Figure 1). Unfortunately, the numerous, often complex and asymmetric, changes in regulatory policy that have occurred during the post-divestiture period make it difficult to specify a cause. A not surprising result is that the various explanations offered tend to conflict.[1]

Figure 1:
Real Consumer Price Index For Interstate Long-Distance Service
(CPI Index: 1982-84 = 100)



[1] See Ward (1995), MacAvoy (1995), Kahai, et. al. (1995), and Knittel (1997).

Table 1:
Estimates of Market Power in the Interstate Long-Distance Telecommunications Market

Study	AT&T's Lerner index	Sprint and MCI's Lerner index
Ward (1995)		
Interstate, Regional Data[b]	0.16	0.07
Intrastate, Regional Data[b]	0.19	0.057
Kahai, et.al. (1996)		
Interstate, National Data[b]	0.13/0.29[a]	--
MacAvoy (1996)		
Interstate, Regional Data[b]	0.62	0.61
Knittel (1997)		
Interstate, National Data[b]	0.65[c]	0.65[c]

[a] Market power based on AT&T's share of interstate output and industry assets, respectively.
[b] Price data based on Message Toll Service (MTS), a switched long-distance service used primarily by residential consumers.
[c] Lerner index based on the weighted average price of AT&T, MCI and Sprint.

The findings of Ward (1995) and Kahai, et. al. (1996) are based on various models of oligopoly market conduct. Examining the tariffed prices of the long-distance carriers, the authors derive estimates of AT&T, Sprint, and MCI's Lerner indices of market power.[2] Both papers conclude that long-distance service prices have converged to their competitive levels; while there is some variation in their estimates, in general the price markups are found not to exceed 20 percent, indicating a lack of significant market power (see Table 1). In achieving these results both papers impose significant restrictions on the market conduct of the long-distance carriers. For example, Ward's model restricts carrier behavior to be consistent with Cournot equilibrium conduct and Kahai, et. al.

[2] Carrier i's Lerner index is defined as $\mathcal{L}_i = (P_i - MC_i)/P_i$, where P_i and MC_i are firm i's price and marginal cost, respectively.

impose the Dominant Firm/Competitive Fringe (DF/CF) model, which assumes AT&T's rivals are price takers while AT&T is the sole price maker.[3] In addition, both papers restrict the assumed behavioral interaction to be unchanged over the sample period.

Based on premises that differ from Ward and Kahai, et. al., MacAvoy (1995) and Knittel (1997) conclude that performance in the long-distance market diverges significantly from a competitive outcome; examining tariffed prices, the authors derive Lerner indices in excess of 50 percent, indicating substantial market power (see Table 1). The fundamental assumption made by MacAvoy and Knittel is that marginal costs are measured with sufficient accuracy from accounting data, which in turn are used directly by the researcher to calculate market power. MacAvoy attributes the substantial price markups to tacit collusion among the long-distance carriers. His empirical evidence comes from regressing the weighted average Lerner index of AT&T, MCI, and Sprint on the Herfindahl index of market concentration.[4] MacAvoy discovers a negative relationship between market power and concentration. Since we would expect to see the opposite relationship in a non-cooperative oligopoly market, he concludes that tacit collusion is what is driving market power.

Knittel's hypothesis is that the substantial markup of long-distance prices is derived from customer search and switching costs. He regresses a carrier's Lerner index on the variables *FEE* and *STDRATES*, where *FEE* is the amount charged by local carriers when a customer switches long-distance providers and *STDRATES* is the standard

[3] The DF/CF model also imposes product homogeneity (i.e., a single market price for interstate long-distance service). This is an exception to the literature reviewed in this paper. Likewise, the model presented in section III is generalized to allow for product heterogeneity.

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deviation of rates for a firm in a given year. *FEE* is a proxy for the switching costs present in the market and *STDRATES* captures the costs of searching for a carrier offering the lowest price. The positive and highly significant coefficients on these variables support the author's hypothesis that search and switching costs are significant determinants of market power in the long-distance market.

In this paper I examine market power in the long-distance market by implementing a static oligopoly model that nests various types of market conduct from perfect competition to Cournot and joint profit maximization. In particular, the model does not restrict market conduct to be consistent with a *single* theory of oligopoly, as do Ward and Kahai, et. al., but derives an estimate of market conduct that is consistent with the data. Further, Ward and Kahai, et. al. assume market conduct is time invariant. Unfortunately, this simplifying assumption is overly restrictive when examining markets, such as long-distance telecommunications, that are experiencing significant structural change. For this reason I disaggregate the time-series data in this study into subsamples according to the occurrence of hypothesized changes in market structure. More specifically, I allow for market conduct to vary over time in response to changes in the regulatory environment.

Finally, to assess the robustness of the model, and corroborate the results derived from MacAvoy and Knittel, I examine the model subject to two specifications of marginal cost: (1) complete cost information – each component of the marginal cost function is observed by the econometrician; (2) incomplete cost information – one or

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[4] The Herfindahl index is defined as $H = \sum_{i=1}^{I} MS_i^2$, where MS_i is the market share of the i^{th} firm in a

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more components of marginal cost are not observed by the econometrician. Both specifications require the functional form of marginal cost be properly specified and the firm to have complete information on this function. The analysis of market conduct under specification (2) is made tenable by using information on changes in the observed components of marginal cost (such as a decrease in access fees), plus the observed changes in the equilibrium outcomes.[5]

The following section describes the FCC's (de)regulatory policies implemented during the post-divestiture period and the hypothesized impact of these policies on the carriers' prices and market power. Section 2.3 describes the model used in this study. Section 2.4 presents the results and Section 2.5 concludes. Before proceeding I briefly summarize my findings.

First, I discover that reductions in access fees and the development of "equal access" were responsible for significant portions of the decline in interstate MTS rates and a corresponding reduction in the carriers' market power.

Second, during this period there were two major changes in the Federal Communications Commission's (FCC) regulation of AT&T's rates for interstate service. The first change was the decision to switch from rate-of-return regulation to price-cap regulation. The second was the FCC's reclassification of AT&T as a "nondominant" common carrier, which eliminated price-cap regulatory constraints on AT&T's domestic interstate service. As we shall see, neither of these policies were responsible for the

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market comprised of *I* firms.

[5] See Bresnahan (1989) for a survey of this methodology. The empirical approach to estimating a firm's market conduct assuming incomplete cost information was classified by the author as the "New Empirical Industrial Organization (NEIO)." This title has now become prevalent in the literature.

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decline in MTS rates. In fact, while price-cap regulation had an insignificant impact, my analysis demonstrates that rate deregulation actually contributed to the recent increases in MTS rates and served to restore an appreciable amount of the long-distance carriers' market power.

Third, while AT&T's supply relation appears to be robust to the various specifications of marginal cost, the supply relation of AT&T's rivals (referred to as "other common carriers" or OCCs) is sensitive to the marginal cost specifications. One possible explanation for this result is that production of long-distance telephone service is susceptible to "learning by doing." That is, (*i*) the construction of a long-distance network, (*ii*) the marketing expertise necessary to acquire a customer base, (*iii*) the conversion of customers to equal access service, and (*iv*) the "learning" acquired from these experiences introduce an additional component into the cost function that is difficult to measure or observe.

2.2 Background

A long-distance company operates a communications network that connects the local exchange carriers' (LECs') networks. However, the long-distance network does not connect directly to its customers. Instead, the LECs, such as the Regional Bell Operating Companies (RBOCs) and GTE, transport telephone calls between the customers' premises and the long-distance network. Carrier access to the local network is an integral input to the production of long-distance telephone service. The price of this input – or access fee – currently represents approximately 40 percent of the long-distance carriers' total costs and a substantially greater percentage of their marginal costs.

The Modification of Final Judgment (MFJ) settled the Department of Justice's 1974 antitrust suit against AT&T and went into effect on January 1, 1984.[6] One of the requirements of the MFJ was that access fees replace the separations and settlements system.[7] The FCC's subsequent access charge ruling significantly reduced the long-distance carriers' burden in recovery of LEC common network costs.[8] First, it instituted a "subscriber line charge" (SLC) which shifted the recovery of a sizable portion of the LECs' fixed costs, previously recovered from long-distance companies, to final consumers. The SLC first appeared on customers' *local* telephone bills in 1984, and the revenue earned from this charge grew from $1.3 billion to $6.1 billion in 1991.[9] Second, the FCC instituted a series of accounting changes which effectively reduced interstate costs while increasing intrastate costs. The net effect of these accounting changes was to reduce carrier access fees an additional $4.5 billion between 1984 and 1991.[10] Figure 2 demonstrates the dramatic overall decline in access fees during the post-divestiture period. Therefore, it is reasonable to believe that the declining cost of access was responsible for a significant portion of the post-divestiture reduction in MTS rates. The results strongly confirm this hypothesis.

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[6] The "M" in MFJ refers to the modification of a 1956 consent decree to which AT&T had agreed, settling a 1949 antitrust suit. The MFJ required AT&T to *divest* its RBOCs, thus the terms MFJ and divestiture are often used synonymously.

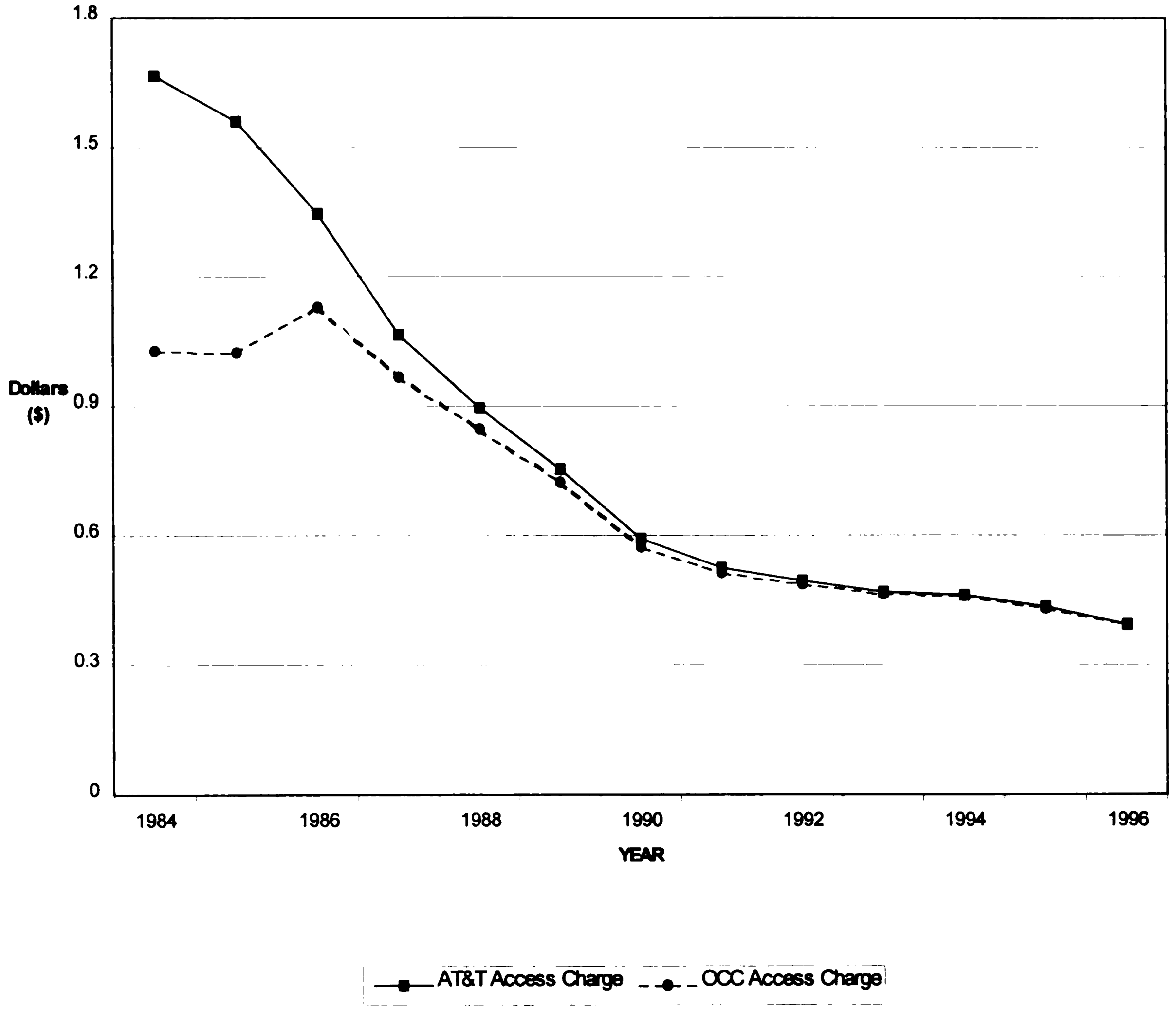
[7] See Brock (1994), p.174. The separations and settlements system, as modified by the Ozark Plan in 1970, shifted a disproportionate share of the non-traffic-sensitive costs from local to toll rates. Per Horwitz (1989, p.354) "The Ozark formula shifted about 1 percent per year of non-traffic sensitive costs to toll from 1971 to 1984. As a result, the increase in local telephone rates from 1967 to 1984 was the fourth lowest among all goods surveyed in the Consumer Price Index."

[8] See *MTS and WATS Market-Structure*, Third Report and Order, CC Dkt. No. 78-72, 93 F.C.C. 2d 241, 251, 252.

[9] See Taylor and Taylor (1993), p.186.

[10] Ibid.

Figure 2:
Average Interstate, Real Access Charge for a 10 Minute Telephone Call



Another stipulation of the MFJ required the RBOCs to offer all long-distance carriers "equal access" to the local telephone network.[11] Equal access, also called 1+ dialing, allows non-AT&T customers to contact their long-distance carrier without dialing extra digits. As a result, AT&T's competitors were able to reduce the amount of product differentiation in this market by offering services comparable in quality to AT&T's. The implementation of equal access by the LECs was an ongoing process throughout the 1980s (see Figure 3). Today, for all practical purposes, the implementation of equal access is complete with 99.4 percent of all LEC local lines providing dialing parity to all long-distance carriers and non-equal access service accounting for less than 1 percent of non-AT&T long-distance service.[12] The hypothesis of this paper is that the development of equal access service among AT&T's rivals diminished the carriers' market power and in part caused the post-divestiture decline in interstate MTS prices. The results I obtain confirm this hypothesis.

In July 1989 the FCC ceased regulating AT&T's interstate rates under rate-of-return regulation and implemented a more flexible price-cap regulatory policy.[13] The price-cap plan required AT&T's rates to fall within a specific upper and lower price band; an extended filing period was required for rate requests lying outside of the price band.[14] The upper and lower price bands were reduced by 3 percent on an annual basis, of which

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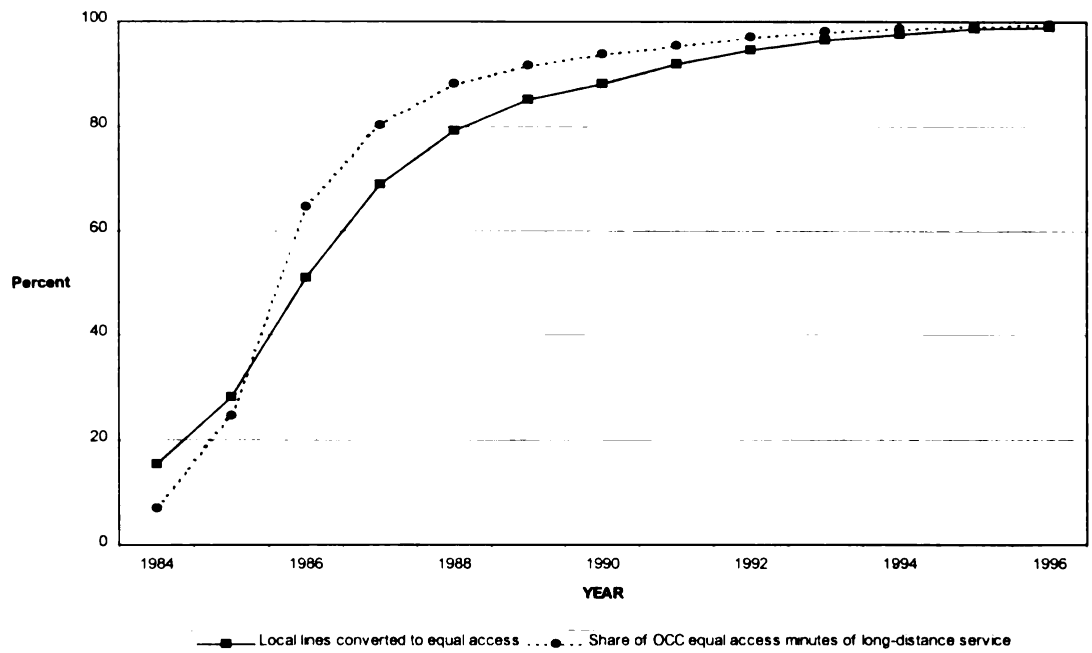
[11] See *United States v. AT&T*, 552 F. Supp. 233.

[12] See FCC (1997a), table 2.3 and 2.20.

[13] See *Policy and Rules Concerning Rates for Dominant Carriers*, Report and Order and Second Further Notice of Proposed Rulemaking, CC Dkt. No. 87-313, 4 F.C.C. Rcd. 2877 (1989).

[14] The filing process consisted of a submission by the regulated carrier for a new tariff, followed by a 30-60 day period during which the FCC could accept or reject the requested tariff.

Figure 3:
The Development of Equal Access



2.5 percentage points represented historical annual productivity growth and 0.5 percentage point was a "Consumer Productivity Dividend."[15]

One motivation for implementing price-cap regulation was to enable AT&T to respond more quickly to fluctuations in the market environment, such as a change in a competitor's price. It was argued that removing certain constraints on the interaction between regulated and non-regulated carriers would enhance competition, promote efficient firm behavior and thereby produce a decline in the price of long-distance service.[16] However, Huber, et. al. (1992) and MacAvoy (1996) have argued that granting AT&T pricing flexibility enables the carrier to retaliate more effectively against a competitor's price reduction and that this threat of retaliation, made credible by the flexibility of price-caps, instead promotes less competition. MacAvoy states "while [price-cap] tariffs prevented 'predation,' they had in place the flexibility to warn the smaller carriers against strategic discounting to shift market share."[17] Huber observed that since price-caps have been imposed "both sides have embraced umbrella pricing under the calming canopy of FCC regulation. AT&T sets the prices. MCI and Sprint signal their acquiescence in tariffs they insist on filing with the FCC."[18] Therefore, while a hypothesis of this paper is that price-cap regulation imposed a structural change on the interaction between long-distance carriers, given the possibility of a competitive or

[15] Ibid. at 1989-97, 2894, 3001.
[16] Ibid. at 3066. While efficient firm behavior was an expected benefit, there was concern with another possibility: predatory pricing. Specifically, AT&T might exploit its market power in the provision of certain services (inbound WATS & MTS) to charge a price below cost for competitive services (outbound WATS and VNS). See Kahai, et. al. (1995) for a discussion on, and empirical test for, predation in the long-distance market. Their findings "yield no support for the argument that reduced regulation has led to predation. " (p. 666)
[17] See MacAvoy (1996), p.68.
[18] See Huber, et. al. (1992), p.3.44.

collusive response, its impact is ex-ante indeterminate. In any case, my results reject the hypothesis. The estimated impact of price-cap regulation on MTS rates was economically insubstantial and statistically insignificant.

In October 1995 AT&T's unique position as the sole rate regulated interstate long-distance carrier was eliminated when the FCC unanimously granted the carrier's petition to be reclassified as a "nondominant" common carrier.[19] AT&T not only was freed from price-cap regulation of its domestic interstate services, but also could file tariffs on a one-day notice and did not have to submit cost support data for any proposed rate change. The FCC's decision to reclassify AT&T assumed that the carrier lacked market power in the domestic interstate long-distance market. While the Commission noted that the market was characterized by a three firm oligopoly in which AT&T demonstrated significant price leadership, they ruled that the evidence was "conflicting and inconclusive as to the issue of tacit price coordination."[20] To the extent the condition did exist, however, it would be "a problem generic to the interexchange industry and not specific to AT&T...[and since] they relate to the industry as a whole, these issues do not preclude our concluding that AT&T lacks the power to raise residential prices unilaterally above competitive levels."[21]

The impact of rate deregulation also cannot be predicted ex-ante. While complete pricing flexibility enables the carrier to compete more effectively, it likewise bestows

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[19] AT&T filed its petition on Sept. 22, 1993: See *Motion for Reclassification of American Telephone and Telegraph Company as a Non-Dominant Carrier*, CC Dkt. No. 79-252. The petition was finally granted on Oct. 13, 1995: See *Motion of AT&T Corp. to be Reclassified as a Non-Dominant Carrier*, CC Dkt. No. 95-427. AT&T's petition to be reclassified as a non-dominant carrier in the international long-distance market was deferred to a later date.
[20] See Oct. 13, 1995 Motion.

upon the carrier an ability to retaliate against deviations from joint profit maximizing behavior.[22] The results in this paper suggest that rate deregulation discouraged AT&T from behaving in a more competitive manner. Thus, the FCC's reclassification of AT&T as a "nondominant" carrier explains a portion of the recent increase in MTS rates and the restoration of an appreciable amount of market power.

2.3 A Model of Firm Demand and Conduct

First, I describe a static oligopoly model and its specification under two assumptions of marginal cost: (1) complete cost information (i.e., marginal cost is observed by the econometrician), and (2) incomplete cost information (i.e., one or more components of marginal cost are not observed by the econometrician). I conclude the section by formulating a hypothesis test to determine the marginal cost specification that best fits the data.

Consider a set of two firms ($i = 1,2$) each of which supply their service at prices P_i and choose outputs Q_i to maximize their profits Π_i,

$$\Pi_i = P_i(Q_i, Q_j, Y_i, \delta_i)Q_i - C_i(Q_i, Z_i, F_i, \Gamma_i) \qquad \text{for } i \neq j$$

where,
- $P_i(\bullet)$ = Firm i's inverse demand function;
- Y_i = Vector of exogenous firm i specific demand shift variables;
- δ_i = Unknown parameters of firm i's inverse demand function;
- $C_i(\bullet)$ = Firm i's total cost function;
- Z_i = Vector of exogenous firm i specific cost shift variables;

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[21] Ibid. In other words, the FCC passed on addressing a regulatory solution to the collective market power possessed by the big three long-distance carriers.

[22] Specifically, cartel stability is facilitated by a member's ability to inflict discomfort upon those that deviate from the collusive agreement. Accordingly, deregulation may have enhanced the efficacy of AT&T's punishment strategies and thus reduced the expected payoff to shirking the cartel agreement. Under this scenario we would expect to observe an increase (or at least not a decrease) in AT&T's price. See Jacquemin and Slade (1989) and references therein.

F_i = Vector of firm i's fixed production costs; and
Γ_i = Unknown parameters of firm i's cost function.

The first order condition for firm i with respect to Q_i is

$$\frac{d\Pi_i}{dQ_i} = P_i + Q_i \frac{\partial P_i}{\partial Q_i} + Q_i \frac{\partial P_i}{\partial Q_j}\lambda_i - \frac{\partial C_i}{\partial Q_i} = 0 \qquad (2.1\text{-a})$$

or,

$$P_i = -Q_i \frac{\partial P_i}{\partial Q_i} - Q_i \frac{\partial P_i}{\partial Q_i}\lambda_i + \frac{\partial C_i}{\partial Q_i} \qquad (2.1\text{-b})$$

where, in equation (2.1-a) $\left(P_i + Q_i\,\partial P_i/\partial Q_i + Q_i\,\partial P_i/\partial Q_j\,\lambda_i\right)$ represent firm i's perceived marginal revenue, while the final term $\left(\partial C_i/\partial Q_i\right)$ is firm i's marginal cost; equation (2.1-b) is firm i's "supply relation." The term λ_i is a parameter that measures the competitiveness of firm i's conduct and is defined as $\partial Q_j/\partial Q_i$.

In the analysis that follows the carriers are aggregated into two groups, where subscript *1* represents the "dominant" common carrier AT&T, and subscript *2* represents the "nondominant" or other common carriers (OCCs). There are several justifications for aggregating AT&T's rivals into a single category. First, for much of the post-divestiture period there has been asymmetric regulation in the long-distance market. Specifically, AT&T has been subject to rate regulation while the OCCs have been rate deregulated. Second, while the OCCs are quite large in number, they are predominantly characterized by two firms with similar capacity and revenue market shares: Sprint and MCI.[23] Third, there appears to be significant uniformity in the cost functions of the

[23] Average Capacity Market Share (ACMS): Between 1985-90 MCI and Sprint's ACMS were 22% and 25%, respectively, and comprised 77% of the OCC ACMS. Between 1991-96 MCI and Sprint's ACMS were 23% and 21%, respectively, and comprised 76% of the OCC ACMS. Average Revenue Market Share (ARMS): Between 1985-90 MCI and Sprint's ARMS were 10% and 7%, respectively, and comprised 71%

OCCs. Specifically, access fees are regulated by the FCC. Thus, while there is variation based on the quality of access (equal vs. non-equal), within a particular category the fee is uniform across carriers. In addition, non-executive labor is highly unionized in the telecommunications industry and there is little variation in the union influenced wage across carriers.

In the standard empirical application of an NEIO model the firms' supply relations and demand functions are estimated simultaneously. To accomplish this end a functional form is specified for each firm's inverse demand and marginal cost functions. In addition, to capture the impact of regulatory change on firm conduct a function is specified indicating the possible determinants of conduct.

I begin with specification of the market conduct equation. In the empirical literature estimates of conduct, such as λ_i in equation (2.1-b), are used to describe equilibrium behavior consistent with a particular theory of oligopoly. For example, $\lambda_i \cong -\frac{\partial P_i / \partial Q_i}{\partial P_i / \partial Q_j}$ for $i,j=1,2$ and $i \neq j$ implies conduct approaching perfect competition;[24] $\lambda_1 > 0$ and $\lambda_2 = 0$ suggests that firm 1 is the Stackelberg leader; $\lambda_1 = \lambda_2 = 0$ is consistent with Cournot behavior; non-competitive behavior is identified when $\lambda_1, \lambda_2 > 0$; and joint profit maximization is achieved when $\lambda_1 = \lambda_2 = 1$. In the studies by Ward and Kahai, et. al. the conduct parameters are restricted to predetermined values and assumed time invariant. In particular, Ward restricts market conduct to be consistent with Cournot

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of the OCC ARMS. Between 1991-96 MCI and Sprint's ARMS were 16% and 9%, respectively, and comprised 65% of the OCC ARMS.

[24] Notice if Q_i and Q_j are perfect substitutes ($\partial P_i/\partial Q_i = \partial P_i/\partial Q_i = 0$) the numerator and denominator of the expression are zero and the quotient is undefined.

behavior and assumes the conduct parameters are constant across carriers and over time: $\lambda_{it} = 0$ for all i and t. Kahai, et. al. allow conduct to vary across firms, where the OCCs are restricted to being price takers while AT&T is the price maker, and assume the relationship is time invariant: $\lambda_{1t} \geq -1$ and $\lambda_{2t} = -1$ for all t. In this paper I expand upon this research by allowing market conduct to vary both across firms i and over time t. As specified below, the model nests a variety of oligopoly models, including those examined by Ward and Kahai, et.al. In particular, I differentiate between AT&T and OCC market conduct and examine the changes in the two groups' conduct that result from regulatory change. This approach is similar to Spiller and Favaro (1984), Gelfand and Spiller (1987), and Rubinovitz (1993). The former two papers analyze the market conduct of a group of "large" and "small" Uruguayan banks and determine the change in conduct following entry deregulation. The latter paper examines the change in market conduct of (franchise) monopoly cable TV carriers following rate deregulation.

The linear approximation of firm i's market conduct is specified as

$$\lambda_i = \lambda_{i0} + \lambda_{i1} EA + \lambda_{i2} PC + \lambda_{i3} DEREG \tag{2.2}$$

where, *EA* equals the percentage of LEC access lines converted to equal access; *PC* and *DEREG* are dummy variables equal to one if AT&T is subject to price-cap regulation or rate deregulation, respectively, and zero otherwise; λ_{i0} is firm i's (baseline) market conduct parameter; λ_{i1} is the change in firm i's market conduct parameter attributable to the development of equal access; and λ_{i2} and λ_{i3} measure the change in firm i's market conduct parameter attributed to the implementation of price-cap regulation and rate deregulation, respectively. Notice that this equation nests the cases where *EA*, *PC*, and

DEREG have no effect on the firms' market conduct and, therefore, allows for time invariant conduct. Another possible outcome is $\lambda_1 = \lambda_2$ and, thus, the specification also nests the case that market conduct is identical across firms.

Next, I specify the functional forms imposed on the inverse demand and marginal cost functions. A log-linear function is assumed for both and specified as follows:

Inverse demand

$$\begin{aligned} \ln P_i = {} & \delta_{i0} + \delta_{i1} \ln Q_i + \delta_{i2} \ln Q_j + \delta_{i3} \ln LOCAL + \delta_{i4} \ln PHONE \\ & + \delta_{i5} (\ln PHONE)^2 + \delta_{i6} \ln INCOME + \delta_{i7} \ln QEA_i + \delta_{i8} TIME + \varepsilon_{di} \end{aligned} \qquad (2.3)$$

The six exogenous demand shift variables are defined as follows: ln*LOCAL* is the natural log of the real consumer price index (CPI) for local telephone service. This variable is included to control for the hypothesized complementary relationship of local to long-distance service.[25] Therefore, a negative estimated coefficient is expected on ln*LOCAL*. ln*PHONE* is the natural log of the number of U.S. households that subscribe to local telephone service, and $(\ln PHONE)^2$ is ln*PHONE* squared. A nonlinear (quadratic) relationship between ln*PHONE* and $\ln P_1$ is allowed due to the network characteristics of telecommunications demand: a doubling of subscribers is likely to more than double demand. ln*INCOME* is the natural log of real personal disposable income. An increase in real income should increase the demand for long-distance service. $\ln QEA_i$ is the natural log of the percentage of carrier *i*'s minutes of interstate long-distance telephone service that are equal access minutes. Notice that this variable is only pertinent

[25] For an empirical analysis of the complementary relationship between local and long-distance service see Hausman, Tardiff, and Belinfante (1993). This hypothesized relationship is also made (and confirmed) in Ward and Kahai, et. al.

Table 2:
Variable Names, Definitions, and Descriptive Statistics

Variable	Definition	Mean	Standard Deviation	Source
lnP_i	Natural log of carrier i's real tariff price for a daytime, 100 mile, 10 minute interstate Message Toll Service (MTS) telephone call.*	ATT = 0.648 OCC = 0.635	0.219 0.212	a
lnQ_i	Natural log of carrier i's switched access minutes for interstate long-distance telephone service (in billions).	ATT = 3.849 OCC = 3.185	0.219 0.623	b
Q_i/Q_j	Carrier i's switched access minutes divided by Carrier j's switched access minutes.	ATT = 2.126 OCC = 0.554	1.017 0.193	b
ln*LOCAL*	Natural log of the real consumer price index (CPI) for local telephone service (1982-84=100).+	4.74	0.060	a
ln*PHONE*	Natural log of the number of U.S. households subscribing to local telephone service (in millions).	4.49	0.046	b
$(\ln PHONE)^2$	ln*PHONE* * ln*PHONE*	20.14	0.417	b
ln*INCOME*	Natural log of real per capita personal disposable income. +	9.44	0.059	c
lnQEA_2	Natural log of the percentage of OCC interstate switched minutes that are equal access minutes.	0.901	0.125	b
TIME	Linear time trend included to control for unobserved changes in demand.	23	13.13	–
ln$ACCESS_i$	Natural log of carrier i's real average access fee for a 10 minute telephone call.^	ATT = – 0.46 OCC = –0.98	0.407 0.489	a

Sources: (a) FCC, Industry Analysis Division, *Reference Book: Rates, Indexes, and Household Expenditure for Telephone Services* (March 1997); (b) FCC, Industry Analysis Division, *Trends in Telephone Service* (March 1997); and (c) Department of Commerce, Bureau of Economic Analysis. Data are available from their webpage at http://www.bea.doc.gov.

* MTS is a switched service (i.e., originates and terminates on a LEC's local network), used primarily by small businesses and households. The real MTS price is calculated by deflating the nominal price with the consumer price index for all goods and services (i.e., the implicit price deflator).

+ Real price are calculated by deflating nominal prices with the implicit price deflator.

^ Access fees are charged on a per minute basis and consist of four components: (1) an originating carrier common line fee; (2) a terminating carrier common line fee; (3) a traffic sensitive fee; and (4) a non-traffic sensitive fee. The real access fee is calculated by deflating the nominal price with the implicit price deflator. AT&T's real per minute access fee is based on the fee for equal access. OCCs' real per minute access fee is calculated as follows: [*%EA* x *EAFee*] + [(1-*%EA*) x *EAFee* x (1-*%Discount*)], where *%EA* is the percentage of OCC equal access minutes, *EAFee* is the equal access fee, and *%Discount* is the percentage reduction in access fee for non-equal access (45%).

to the OCCs' demand function since all of AT&T's interstate services were offered on an equal access basis.[26] Given the superior quality of equal access service, the hypothesis is that there is a positive correlation between lnQEA_2 and lnP_2 ($\hat{\delta}_{27}$ >0). *TIME* is a linear time trend included to control for unobserved changes in demand, such as an increase or decrease in the price of facsimile machines, data processing equipment, etc. No hypothesis is formulated on the coefficient estimate on *TIME.*

The assumption of a Cobb-Douglas inverse demand function is consistent with other empirical studies of the interLATA market.[27] This assumption produces the following partial derivatives with respect to Q_i and Q_j:

$$\frac{\partial P_i}{\partial Q_i} = \delta_{i1}\left(\frac{P_i}{Q_i}\right); \text{ and}$$

$$\frac{\partial P_i}{\partial Q_j} = \delta_{i2}\left(\frac{P_i}{Q_j}\right)$$

<u>Marginal cost</u>

Complete information: $\ln MC_i = \Gamma_{i1} \ln ACCESS_i + \varepsilon_{ci}$ (2.4-a)

Incomplete information: $\ln MC_i = \gamma_{i0} + \gamma_{i1} \ln ACCESS_i + \phi_{ci}$ (2.4-b)

Inclusion of an intercept parameter (γ_{i0}) in equation (2.4-b) controls for changes in the unobserved components of marginal cost. Thus, the exclusion of an intercept in (2.4-a) presumes marginal cost is comprised of a single component: $ACCESS_i$. The

[26] The implementation and conversion to equal access technology was a fundamental requirement of the divestiture. Thus, the development of equal access services among the OCCs is deemed an exogenous variable dictated by FCC regulation.
[27] See Ward (1995), Gatto, Kelejian, and Stephan (1988), and Gatto, et. al. (1988). The choice of a log-linear demand function was supported by results from MacKinnon, White, and Davidson's (1983) P_E test. While a linear specification is rejected for both AT&T and the OCCs inverse demand, the log-linear specification is not rejected for either group (See Appendix 2A).

assumption that marginal cost is independent of the carrier's output appears reasonable given the characteristics of fiber optic transmission technology and the significant excess capacity that the facility-based carriers possess. The assumption of a log-linear functional form is consistent with other empirical studies of the long-distance market.[28]

The exogenous cost shift variable $\ln ACCESS_i$ is the natural log of the firm i specific average real price paid to a LEC for a 10 minute telephone call. Access to the local exchange network is the predominant input required for the production of long-distance service. Therefore, we would expect an increase in the price of this input to have a positive impact on the market price.

To derive the supply relation assuming *complete cost information*, substitute into equation (2.1-b) the determinants of market conduct as specified in equation (2.2), the partial derivatives derived from the inverse demand equation (2.3) and the marginal cost equation (2.4-a). Taking the natural log of both sides of the equation produces the following:

$$\ln P_i = -\ln\left[1+\delta_{i1}+\lambda_{i0}\delta_{i2}\frac{Q_i}{Q_j}+\lambda_{i1}\delta_{i2}\frac{Q_i}{Q_j}EA+\lambda_{i2}\delta_{i2}\frac{Q_i}{Q_j}PC+\lambda_{i3}\delta_{i2}\frac{Q_i}{Q_j}DEREG\right] + \Gamma_{i1}\ln ACCESS_i + \varepsilon_{ci} \qquad (2.5)$$

Equation (2.5) can be simplified if one realizes that a linear approximation of the function $y = \ln(1+x) \cong x$, for the small values of x.[29] Therefore, firm i's supply relation can be rewritten as follows:

[28] See Ward (1995).

[29] "x" is calculated as the market conduct function λ_i, as specified in equation (2.2), interacted with Q_i/Q_j and δ_{i2}. Estimates of x, as reported in section V, are the following: $\hat{x}_1 = -0.10$; $\hat{x}_2 = 0.04$. A non-linear regression is performed on equation (2.5) and the results are reported in appendix 2B. The magnitude of the coefficient estimates is different but the results are unchanged. Given the simplified interpretation and

$$\ln P_i = -\delta_{i1} - \lambda_{i0}\delta_{i2}\frac{Q_i}{Q_j} - \lambda_{i1}\delta_{i2}\frac{Q_i}{Q_j}EA - \lambda_{i2}\delta_{i2}\frac{Q_i}{Q_j}PC - \lambda_{i3}\delta_{i2}\frac{Q_i}{Q_j}DEREG + \Gamma_{i1}\ln ACCESS_i + \varepsilon_{ci} \quad (2.6)$$

Derivation of the supply relation assuming *incomplete cost information* is identical to the derivation of equation (2.6) except the marginal cost function is specified according to equation (2.4-b); that is, the intercept term is redefined as $-\delta_{i1} + \gamma_{i0}$ instead of $-\delta_{i1}$, where the parameter γ_{i0} represents impact on firm *i*'s price from changes in the unobserved components of its marginal costs. Therefore, the two hypothesis are the following:

H_0: Intercept = $-\delta_{i1}$ [Specification (2.4-a)]

H_1: Intercept $\geq -\delta_{i1}$ [Specification (2.4-b)]

Specifically, the alternative hypothesis (H_1) is that the intercept equal $-\delta_{i1} + \gamma_{i0}$. However, since γ_{i0} is unobserved the inequality condition is sufficient to reject H_0. To determine if specification (2.4-a) holds I perform a test of the linear restriction that the intercept in equation (2.6) equals $-\hat{\delta}_{i1}$, where $\hat{\delta}_{i1}$ is the coefficient estimate derived from a regression of the inverse demand equation (2.3).[30]

The model consists of a system of four time series equations: two equations for the two firms, for each time period. The inverse demand equations (2.3) and the supply relations (2.6) represent the estimating specifications.

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analysis of the linear model, the results reported in the body of the paper are from the linear regression of equation (2.6).

[30] The test utilizes the system covariance matrix, thus, requiring estimation of the demand and supply equations simultaneously as a system.

2.4 The Empirical Results

The data used are 45 quarterly observations covering the time period 1985:4 to 1996:4. Given that output and price are determined simultaneously, estimation of the inverse demand functions and supply relations with ordinary least squares would produce inconsistent and biased coefficient estimates. Accordingly, this paper utilizes a two-stage least squares regression procedure. The inverse demand equations contain two endogenous right hand side variables, $\ln Q_1$ and $\ln Q_2$. The observed exogenous cost shift variables $\ln ACCESS_1$ and $\ln ACCESS_2$ are used as instruments to identify equations (2.3) and provide consistent estimates of the parameters δ. Likewise, the endogenous right hand side variable in the supply relation Q_i/Q_j requires the exogenous demand shift variables be used as instruments to identify the supply relations and provide consistent estimates of the parameters λ.[31]

The inverse demand results are listed in Table 3. The second and third columns list the coefficient estimates from AT&T and the OCCs' inverse demand functions, respectively. Inverting the coefficient on $\ln Q_i$ provides an estimate of the carriers' own price elasticities of demand equal to -1.86 for AT&T and -2.61 for the OCCs. In comparison to previous research on demand for interstate long-distance service, the

[31] This identification procedure is somewhat atypical for two reasons. First, instead of considering the correlation between the instruments and outputs Q_i and Q_j, it examines the correlation between the instruments and the ratio of firm i and j's output (Q_i/Q_j). Second, the instruments are interacted with the exogenous variables *EA*, *PC* and *DEREG*. See Appendix 2C for the first stage regression results of the four endogenous variables Q_1/Q_2, Q_2/Q_1, $\ln Q_1$, and $\ln Q_2$.

Table 3:
Two-Stage Least Squares Estimates:
Inverse Demand Functions

Carrier =	AT&T	OCC
Dependent Variable =	$\ln P_1$	$\ln P_2$
Independent Variable	Coefficient (Standard Error)	Coefficient (Standard Error)
INTERCEPT	237.52**	1365.05**
	(26.39)	(284.52)
$\ln Q_i$	– 0.538**	– 0.383*
	(0.173)	(0.212)
$\ln Q_j$	– 0.183**	– 0.168**
	(0.093)	(0.075)
TIME	0.014**	0.041**
	(0.004)	(0.006)
ln*INCOME*	0.130	0.342
	(0.517)	(0.480)
ln*LOCAL*	– 0.158**	– 0.191
	(0.054)	(0.158)
ln*PHONE*	– 572.01**	– 607.71**
	(130.06)	(127.66)
$(\ln PHONE)^2$	63.758**	67.56**
	(14.625)	(14.37)
ln*QEA*		0.099*
		(0.059)
Observations	45	45
F-statistic	145.99	138.5
R-Squared	0.9651	0.9760
Adjusted R-Squared	0.9584	0.9696
Durbin-Watson	1.201	1.398
Instruments:	$\ln ACCESS_1$ $\ln ACCESS_2$	$\ln ACCESS_1$ $\ln ACCESS_2$

* Significant at the 10 % level
** Significant at the 5 % level.

estimates are on the low side but still reasonable.[32] The estimated coefficients on the remaining independent variables in the demand equation are their expected signs, and most of them are significant. The coefficients on rival output, δ_{12} and δ_{22}, are – 0.18 and – 0.17, respectively. Given that the numbers are negative and not equal to the coefficient on $\ln Q_i$ indicates that rival output is an imperfect substitute for own output.[33] The coefficients on *TIME* are 0.14 for AT&T and 0.04 for the OCCs, suggesting that unobserved changes in the market, such as increases or decreases in the prices of terminal equipment have had a positive impact on long-distance demand. The coefficient on $\ln LOCAL$ is – 0.16 for AT&T and – 0.19 for the OCCs. This confirms the hypothesis that local service is a complement to long-distance service. The coefficient on $\ln PHONE$ is – 572.01 for AT&T and –607.71 for the OCCs. Likewise, the coefficient on $(\ln PHONE)^2$ is 63.76 for AT&T and 67.56 for the OCCs. This suggests a nonlinear relationship between subscribership and long-distance demand. The hypothesis of a positive relationship between subscribership and demand for long-distance service is confirmed by examining the first derivative at the sample means of $\ln PHONE$, *PHONE*, and P_i: $\partial P_1/\partial PHONE = 0.05$ and $\partial P_2/\partial PHONE = 0.01$.[34,35] Finally, the positive and significant coefficient on $\ln QEA_2$ of 0.10 indicates that the development of equal access service

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[32] Ward (1995) estimates a lower bound own price elasticity of demand of 2.02 for AT&T and 3.04 for the OCCs. Taking these lower bounds as observations (rather than estimates), I am unable to reject the hypothesis that $\delta_{11} = \frac{1}{2.02}$ (t-statistic = 0.34) and $\delta_{21} = \frac{1}{3.04}$ (t-statistic = 0.56).

[33] The t-statistics for the hypothesis that the coefficients $\ln Q_{11}$ and $\ln Q_{12}$ are identical is 2.89 . Likewise, the t-statistic for the hypothesis that the coefficient on $\ln Q_{21}$ and $\ln Q_{22}$ are identical is 2.46.

[34]
$$\partial P_i/\partial PHONE = \delta_{i5} * (P_i/PHONE) + \delta_{i6} * 2 * (\ln PHONE) * (P_i/PHONE)$$
$$\partial P_1/\partial PHONE = -572.0 * (0.022) + 63.8 * 2 * 4.499 * (0.022) = 0.05$$
$$\partial P_2/\partial PHONE = -607.7 * (0.021) + 67.6 * 2 * 4.499 * (0.021) = 0.01$$

among the OCCs had a positive impact on the demand for their interstate services.[36]

Table 4 presents the results from estimation of the supply relations. The second and third columns list the coefficient estimates from AT&T and the OCCs' supply relation equations, respectively. The exogenous marginal cost shift variable $\ln ACCESS_i$ has a positive and significant impact in both equations. The coefficient estimate of 0.83 and 0.67 on $\ln ACCESS_i$ for AT&T and the OCCs support the hypothesis that decreases in access fees cause significant decreases in the market price. While it might appear that reductions in access fees are being completely passed through to customers in price reductions (i.e., $\Gamma_{i1} \cong 1$) the t-statistic for the hypothesis that $\Gamma_{11} = 1$ is 2.33 and for the hypothesis $\Gamma_{21} = 1$ is 4.02.

The coefficients of primary interest in this study are those on Q_i/Q_j, $(Q_i/Q_j)EA$, $(Q_i/Q_j)PC$, and $(Q_i/Q_j)DEREG$. Notice that the estimated magnitude of the impact of price-caps on the carriers' MTS rates is quite small (– 0.002 for AT&T and – 0.06 for the OCCs) and statistically insignificant. Therefore, it appears that the change in FCC policy from rate-of-return to price-cap regulation did not have a structural impact and as a result market conduct was undisturbed. The estimated effect of a decline in a carrier's relative market share on its rates is positive (0.15 for AT&T and 1.07 for the OCCs) and significant. The coefficient estimate on $(Q_i/Q_j)EA$ is negative (– 0.19 for AT&T and – 1.40 for the OCCs) and significant. These estimates indicates that the development of

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[35] The F-statistic for the hypothesis that $\ln PHONE$ and $(\ln PHONE)^2$ are jointly significant is 3.37 for AT&T and 4.19 for the OCCs.

[36] Recall, AT&T's service was offered on a 1+ basis throughout the sample period, thus, $\ln QEA_1$ is excluded from AT&T's firm specific inverse demand function. The impact of equal access service on AT&T's demand is captured indirectly through the coefficient on $\ln Q_2$.

Table 4:
Two-Stage Least Squares Estimates:
Supply Relations

Carrier =	**AT&T**	**OCC**
Dependent Variable =	$\ln P_1$	$\ln P_2$
Independent Variable	Coefficient (Standard Error)	Coefficient (Standard Error)
INTERCEPT	0.529** (0.093)	0.974** (0.133)
Q_i/Q_j	0.153** (0.021)	1.071* (0.576)
$(Q_i/Q_j)EA$	– 0.192** (0.038)	– 1.397** (0.706)
$(Q_i/Q_j)PC$	– 0.002 (0.012)	– 0.059 (0.052)
$(Q_i/Q_j)DEREG$	0.059** (0.021)	0.105** (0.026)
$\ln ACCESS_i$	0.834** (0.071)	0.674** (0.081)
Observations	45	45
F-statistic	582.8	430.96
R-Squared	0.9831	0.9773
Adjusted R-Squared	0.9814	0.9751
Instruments:	*TIME* $\ln LOCAL$ $\ln PHONE$ $(\ln PHONE)^2$	*TIME* $\ln LOCAL$ $\ln PHONE$ $(\ln PHONE)^2$

* Significant at the 10 % level
** Signifcant at the 5 % level.

equal access did affect the carriers' market conduct. A 10 percent increase in the number of local lines providing equal access is predicted to have a 3.5 percent reduction in AT&T's rates and 6.6 percent reduction in the OCCs rates.[37] Finally, the coefficient estimate on $(Q_i/Q_j)DEREG$ is positive (0.06 for AT&T and 0.11 for the OCCs) and significant. This is an interesting result that directly conflicts with the FCC's argument that AT&T no longer possesses significant market power. It appears that rate deregulation affects the carriers' market conduct by enabling them to exercise more effectively their market power. Evaluated at the mean of the relative market shares since rate deregulation was implemented, the estimated impact of this policy is a 7 percent increase in AT&T's rates and a 9 percent increase in the OCCs' rates.

These eight coefficient estimates (as reported in Table 4), along with the estimates of δ_{i1} and δ_{i2} (as reported in Table 3), are used to estimate the conduct parameters and market power. The conduct parameter estimates, evaluated at the mean of EA and assuming PC, $DEREG = 1$, are the following:

$$\begin{aligned}\hat{\lambda}_1 &= \hat{\lambda}_{10} + \hat{\lambda}_{11}EA + \hat{\lambda}_{12}PC + \hat{\lambda}_{13}DEREG \\ &= (0.15/0.18) - (0.19/0.18)(0.85) - (0.002/0.18) + (0.06/0.18) \\ &= 0.256\end{aligned} \tag{2.7}$$

$$\begin{aligned}\hat{\lambda}_2 &= \hat{\lambda}_{20} + \hat{\lambda}_{21}EA + \hat{\lambda}_{22}PC + \hat{\lambda}_{23}DEREG \\ &= (1.07/0.17) - (1.40/0.17)(0.85) - (0.06/0.17) + (0.11/0.17) \\ &= -0.419\end{aligned} \tag{2.8}$$

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37 $\%\Delta P_i / \%\Delta EA = \lambda_{i1}\delta_{i2} \times Q_i/Q_j \times EA$
$\%\Delta P_1 / \%\Delta EA = -0.19 \times 2.13 \times 0.85 = .34$
$\%\Delta P_2 / \%\Delta EA = -1.40 \times 0.55 \times 0.85 = .65$

where the standard error for $\hat{\lambda}_1$ is 0.056 and for $\hat{\lambda}_2$ is 0.086.[38] Notice that, from a purely computational standpoint, the estimates can easily lie outside the parameter bounds of perfect competition ($\lambda_i \cong -1$) and collusion ($\lambda_i = 1$). The apparent reasonableness of the parameter estimates provides some confidence in the methods used. The economic interpretation suggest that the OCCs behave in a significantly more competitive manner than AT&T ($\hat{\lambda}_1 > \hat{\lambda}_2$).[39] Given the dramatic shift away from AT&T in output market share during the sample period this result has some intuitive appeal. However, the results fail to corroborate any of the predominant theories of market conduct. Joint hypothesis tests performed on the conduct parameters rejected all of the predominant theoretical models: perfect competition (λ_1=$-\delta_{11}Q_1/\delta_{12}Q_2$ and λ_2=$-\delta_{21}Q_2/\delta_{21}Q_1$), constant conjectures (λ_1=λ_2),[40] Stackelberg ($\lambda_1 > 0$ and $\lambda_2 = 0$), and perfect collusion ($\lambda_1 = \lambda_2 = 1$).

A second, and closely related, method by which to examine the degree of competition in the long-distance market is to calculate the carriers' Lerner indices ($\mathcal{L}_i$). The estimates are derived from supply relation equation (2.1-b) after substituting in the partial derivatives (w.r.t. Q_i) of the inverse demand equation (2.3):

$$\hat{\mathcal{L}}_i \equiv \frac{P_i - \partial C_i / \partial Q_i}{P_i} = -\hat{\delta}_{i1} - \hat{\delta}_{i2}\hat{\lambda}_i\left(\frac{\overline{Q}_i}{Q_j}\right)$$

[38] Calculation of the standard errors requires estimation of the demand and supply equations as a system. From this an estimate of the system covariance matrix is produced, and in conjunction with the Delta method, the standard errors are derived. See Greene (1993), p.297 for a description of the Delta method.

[39] The F-statistic of 8.70 rejects the hypothesis that $\hat{\lambda}_1 = \hat{\lambda}_2$.

[40] See Bowley (1924). Note that Cournot model is a special case of the constant conjectures model.

where, $\hat{\delta}_{i1}$ and $\hat{\delta}_{i2}$ are the 2SLS estimates, $\hat{\lambda}_i$ is derived from equations (2.7) and (2.8), and $\left(\frac{\overline{Q_i}}{Q_j}\right)$ is the mean of firm i's relative market share over the entire sample. Imposing these estimates produces the following Lerner indices:

$$\hat{\mathcal{L}}_1 = 0.538 + (0.183)(0.26)(2.1)$$
$$= 0.64$$
$$\hat{\mathcal{L}}_2 = 0.383 + (0.168)(-0.42)(0.55)$$
$$= 0.34$$

where the standard error for $\hat{\mathcal{L}}_1$ is 0.122 and for $\hat{\mathcal{L}}_2$ is 0.064.[41]

The final result to report is that from the hypothesis test of the marginal cost specifications. Recall the two hypothesis are the following:

$$H_0\text{: Intercept} = -\hat{\delta}_{i1} \qquad \text{(complete cost information)}$$

$$H_1\text{: Intercept} \geq -\hat{\delta}_{i1} \qquad \text{(incomplete cost information)}$$

While the null hypothesis cannot be rejected for AT&T's supply relation (t-statistic = 0.1), it is rejected for the OCC supply relation (t-statistic = 2.41). This suggests that AT&T's marginal cost is accurately specified according to equation (2.4-a), while measurement of OCC marginal cost is more complex and involves additional components not observed by the econometrician. The intercept parameter estimate in the OCC supply relation exceeds $-\hat{\delta}_{i1}$ (0.974>0.383) suggesting that the net effect of the unobserved marginal costs components is positive. I provide two possible explanations

[41] Calculation of the standard errors for $\hat{\mathcal{L}}_1$ and $\hat{\mathcal{L}}_2$ follow the same procedure as that for $\hat{\lambda}_1$ and $\hat{\lambda}_2$ described in footnote 38.

for this outcome. First, aggregation of the OCCs' supply relations into a single equation may be inappropriate. However, this argument is diminished by the apparent uniformity of marginal costs across carriers. For example, access fees are regulated by the FCC and variation is primarily attributed to the type of access. Equal and non-equal access fees are controlled for in calculating $\ln ACCESS_2$. In addition, non-executive labor is highly unionized in the telecommunications industry and there is little variation in the union influenced wage across carriers.

A second possible explanation is more compelling and it is the "learning-by-doing" cost savings that accrue in complex network industries such as long-distance telecommunications. Constructing a long-distance network from scratch, the acquisition of marketing expertise,[42] upgrading consumers to equal access service, and the knowledge that is acquired from these experiences may have introduced an additional component to OCC marginal cost that is not sufficiently captured in $\ln ACCESS_2$.

To acquire some perspective on the implications of these estimates of market power it is useful to make comparisons with other estimates of $\mathcal{L}$ in the long-distance telecommunications market, as well as similar estimates for other industries. The top panel in Table 5 includes the results from a variety of empirical studies of market power as surveyed in Bresnahan (1989). The bottom panel includes the results from Ward (1995), MacAvoy (1995), Kahai, et. al. (1996) and Knittel (1997). The average market power index reported in Bresnahan is 0.30. The estimate derived in this paper for AT&T's market power (0.64) clearly falls toward the high end of Bresnahan's reported

[42] Recent evidence on Qwest's controversial marketing alliance with U.S. West and Ameritech suggests that customer acquisition is a formidable task for new entrants. See Keller (1998).

Table 5:
Empirical Estimates of Market Power

Author	Industry	$\mathcal{L}$
Bresnahan's		
Lopez (1984)	Food processing	0.504
Roberts (1984)	Coffee roasting	0.055/0.025[a]
Appelbaum (1982)	Rubber	0.049[c]
Appelbaum (1982)	Textile	0.072[c]
Appelbaum (1982)	Electrical machinery	0.198[c]
Appelbaum (1982)	Tobacco	0.648[c]
Porter (1983)	Railroads	0.40[b]
Slade (1987)	Retail gasoline	0.10
Bresnahan (1981)	Automobiles (1970s)	0.1/0.34[d]
Suslow (1986)	Aluminum (interwar)	0.59
Spiller-Favaro	Banks "before"[e]	0.88/0.21[f]
Spiller-Favaro	Banks "after"[e]	0.40/0.16[f]
Ward (1995)	Long-distance telephone	0.16/0.07[g]
Kahai, et. al. (1996)	Long-distance telephone	0.13[h]
MacAvoy (1995)	Long-distance telephone	0.62/0.61[i]
Knittel (1997)	Long-distance telephone	0.65[j]

[a] Largest and second largest firm, respectively.
[b] When cartel was succeeding: 0 in reversionary periods.
[c] At sample midpoint.
[d] Varies by type of car; larger in standard, luxury segment.
[e] Uruguayan banks before and after entry deregulation.
[f] Large firms/small firms.
[g] Interstate regional data. AT&T and OCCs respectively.
[h] Based on AT&T's output market share.
[i] AT&T and OCCs, respectively.
[j] Weighted average based on AT&T, MCI, and Sprint.

indices, while the estimate derived for the OCCs' market power (0.34) is approximately equal to the average. Given that the industries surveyed in Bresnahan (1989) are likely biased towards those where the researcher expected to find market power, this suggests that AT&T and, to a lesser extent, the OCCs possess substantial market power.

Second, as indicated in the bottom panel of Table 5, there is significant variation in AT&T and the OCCs' estimated Lerner indices. The explanation, argued in this paper, is that these results are the product of the authors' overly restrictive assumptions. Recall, Ward sets the carriers' conduct parameters equal to zero and assumes they are time invariant. Kahai, et. al. also assume a time invariant market conduct and restrict AT&T's rivals to be a competitive "fringe" subject to a residual demand that is dictated by AT&T. Finally, MacAvoy and Knittel derive their estimates assuming marginal cost is accurately measured from accounting data.

This paper overcomes these shortcomings by invoking a model that is sufficiently general. First, unlike Ward and Kahai, et. al., the model does not restrict AT&T's market conduct to a particular value but allows it to vary over the sample period subject to hypothesized regulatory induced changes in the market structure. This specification nests the cases where there is no structural change and no variation in conduct across carriers. However, this paper discovers that market conduct did indeed vary over time and that the behavior of AT&T was distinct from that of the OCCs. Second, unlike MacAvoy and Knittel, the model does not impose a particular specification of marginal cost but nests both the complete and incomplete cost information specifications and tests which specification best fits the data. The results indicate that AT&T's supply relation is not sensitive to either specification, while the OCC's supply relation is indeed sensitive to the specifications and is mismeasured under the specification imposed by MacAvoy and Knittel.[43]

2.5 Conclusion

The FCC's post-divestiture (de)regulatory policy has produced significant gains to consumers in the form of lower prices. The primary determinants of MTS price decreases were the development of equal access and the dramatic reductions in access fees. The first results from a change in the carrier's cost structure and the second from eliminating an important barrier to entry, namely the technical ability to offer a service of comparable quality to the incumbent's service (1+ service).

An important discovery of this paper is that rate deregulation, in particular the 1989 implementation of price-caps and the 1995 reclassification of AT&T as "nondominant", were not responsible for any of the decline in MTS rates. AT&T and the OCCs' MTS rates and Lerner indices of market power actually increased as a result of this rate deregulatory policy. And the carriers' estimated 66 and 31 percent price markups significantly exceeds that which one would expect to find from firms in a competitive market.

One would hope that the success of the FCC's equal access mandate, coupled with the ill effects of rate deregulation, serves as an example to state and federal regulators in their efforts to deregulate the local telephone market. The current controversy involves

[43] OCC marginal cost is underestimated and consequently OCC market power is overestimated.

the FCC's proposed rules in implementing the 1996 Telecommunications Act.[44] Those in opposition to these rules argue that they are too complex and impose regulatory restrictions which have an asymmetric impact on one class or mode of competitors.[45]

While this argument would seem to have merit in the abstract, is it valid based on our past experience in the long-distance telephone market? The development of competition in the long-distance market has taken well over a decade and has been assisted by a regulatory environment that has promoted competitive interaction by removing specific structural impediments. Were it not for the mandatory deployment of equal access technology following the AT&T divestiture it is likely that the long-distance market would not be performing as well as it is. However, the FCC's equal access mandate clearly had an asymmetric impact on one class or mode of competitors. In contrast, FCC policies that removed regulatory asymmetries, such as rate deregulation of AT&T's domestic services, enabled AT&T to exercise better its market power and resulted in a 7 percent increase in the carrier's MTS rates. According to my analysis of the long-distance deregulatory experience, to encourage competitive interaction among the carriers participating in the market ("incumbent" LECs and "competitive" LECs) and provide incentives for new entry, we need an evolving regulatory policy that addresses structural imperfections, while constraining the market power of the dominant carrier.

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[44] The 1996 Telecommunications Act was approved February 8, 1996 as P.L. 104-104, 1996 (S. 652). The FCC's rules for implementing competition in the local telephone market were issued August 8, 1996 – see *First Report and Order, In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996* (CC Docket No. 96-98).
[45] See Harris and Kraft (1997).

Appendix 2A

Residual Demand Specification

The P_E test, as developed by MacKinnon, et. al. (1983), can be used to test a linear versus log-linear model specification. Let the two competing models be denoted

Linear Model: $P_i = \beta_0 + \beta_1 Q_i + \beta_2 Q_j + \beta_3 Y_i + \varepsilon_{di}$; and

Log-Linear Model: $\ln P_i = \delta_0 + \delta_1 \ln Q_i + \delta_2 \ln Q_j + \delta_3 \ln Y_i + \varepsilon_{di}$

Linear Specification Test

H_0: $P_i = \beta_0 + \beta_1 Q_i + \beta_2 Q_j + \beta_3 Y_i + \varepsilon_{di}$

H_1: $\ln P_i = \delta_0 + \delta_1 \ln Q_i + \delta_2 \ln Q_j + \delta_3 \ln Y_i + \varepsilon_{di}$

Log-Linear Specification Test

H_0: $\ln P_i = \delta_0 + \delta_1 \ln Q_i + \delta_2 \ln Q_j + \delta_3 \ln Y_i + \varepsilon_{di}$

H_1: $P_i = \beta_0 + \beta_1 Q_i + \beta_2 Q_j + \beta_3 Y_i + \varepsilon_{di}$

Now let b(linear) and d(log-linear) be the two linear least squares estimates of the parameters vectors. The P_E test for H_1 as an alternative to H_0 is carried out by testing the significance of the coefficient α in the following models:

Linear Specification Test

$y = x'\beta + \alpha\,[\ln \hat{y} - \ln(x'b)] + \varepsilon$

Log-Linear Specification Test

$\ln y = \ln(x)'\gamma + \alpha\,[(\hat{y}) - e^{\ln(x)'d}] + \varepsilon.$

The second term is the difference between predictions of y obtained directly from the H_1 specification (i.e. $\hat{y}$) and the log/exponential of the prediction from the H_0 specification. The t-statistics presented in Table 6 indicate that the log-linear model cannot be rejected in favor of the linear model (t-statistics 0.660 and 0.964). However, the linear model can be rejected in favor of the log-linear model (t-statistics 1.981 and 2.289).

Table 6:
Estimates of α

	Estimate	Standard Error	t-statistic
Linear Test:			
AT&T Inverse Demand	– 1.721	0.869	1.981
OCC Inverse Demand	– 1.406	0.614	2.289
Log-Linear Test:			
AT&T Inverse Demand	0.143	0.217	0.660
OCC Inverse Demand	0.201	0.209	0.964

Appendix 2B

Nonlinear Regression Results

To examine the appropriateness of the linear approximation of firm i's supply relation equation (2.6), I examine estimates derived from the nonlinear supply relation equation (2.5). These results are presented in Table 7 and the derivation of the conduct parameters and Lerner indices follow.

Four coefficient estimates of $\lambda_{i0}\delta_{i2}$, $\lambda_{i1}\delta_{i2}$, $\lambda_{i2}\delta_{i2}$, and $\lambda_{i3}\delta_{i2}$ reported in Table 7, and the estimate of δ_{i2} reported in Table 3 are used to estimate the conduct parameters. The parameter estimates are evaluated at the mean of EA = 0.85 and assume PC, DEREG = 1.

$$\begin{aligned}\hat{\lambda}_1 &= (0.078/0.18)-(0.095/0.18)(0.85)+(0.0004/0.18)+(0.041/0.18)\\ &= 0.215\end{aligned} \tag{2.7B}$$

$$\begin{aligned}\hat{\lambda}_1 &= (0.250/0.17)-(0.501/0.17)(0.85)+(0.008/0.17)+(0.057/0.17)\\ &= -0.652\end{aligned} \tag{2.8B}$$

AT&T and the OCCs' Lerner indices are derived from the supply relation equation (2.1-b) after substituting in the partial derivatives (w.r.t. Q_i) of the inverse demand equation (2.3):

$$\mathcal{L}_i \equiv \frac{P_i - \partial C_i/\partial Q_i}{P_i} = -\hat{\delta}_{i1} - \hat{\delta}_{i2}\hat{\lambda}_i\left(\frac{\overline{Q}_i}{Q_j}\right)$$

where, $\hat{\delta}_{i1}$ and $\hat{\delta}_{i2}$ are the 2SLS estimates, $\hat{\lambda}_i$ is derived from equations (2.7B) and (2.8B) and $\left(\frac{\overline{Q}_i}{Q_j}\right)$ is the mean of firm i's relative market share over the entire sample.

Table 7:
Nonlinear Two-Stage Least Squares Estimates:
Supply Relations

Carrier =	**AT&T**	**OCC**
Dependent Variable	$\ln P_1$	$\ln P_2$
Independent	Coefficient (Standard Error)	Coefficient (Standard Error)
INTERCEPT	0.412**	0.613**
	(0.050)	(0.043)
Q_i/Q_j	0.078**	0.250**
	(0.010)	(0.051)
$(Q_i/Q_j)EA$	– 0.095**	– 0.501**
	(0.022)	(0.090)
$(Q_i/Q_j)PC$	0.0004	– 0.008
	(0.0046)	(0.013)
$(Q_i/Q_j)DEREG$	0.041**	0.057**
	(0.020)	(0.016)
$\ln ACCESS_i$	0.887**	0.789**
	(0.077)	(0.085)
Observations	45	45
F-statistic	3746.67	3050.83
R-Squared	0.9989	0.9987
Adjusted R-Squared	0.9987	0.9984
Instruments:	*TIME* ln*LOCAL* ln*PHONE* $(\ln PHONE)^2$	*TIME* ln*LOCAL* ln*PHONE* $(\ln PHONE)^2$

* Significant at the 10 % level
** Signifcant at the 5 % level.

Imposing these estimates produces the following Lerner indices:

$$\mathcal{L}_1 = 0.538 + (0.183)(0.215)(2.1)$$
$$= 0.621$$
$$\mathcal{L}_2 = 0.383 + (0.168)(-0.652)(0.55)$$
$$= 0.323$$

Appendix 2C

First-Stage Regression Results

Table 8:
First-stage Estimates:
Dependent variable $\ln Q_i$

Carrier = Dependent Variable	AT&T $\ln Q_1$	OCC $\ln Q_2$
Independent	Coefficient (Standard Error)	Coefficient (Standard Error)
INTERCEPT	71.199	548.00^{**}
	(64.106)	(205.61)
TIME	0.011^{**}	0.006
	(0.004)	(0.014)
ln*INCOME*	– 0.085	–0.563
	(0.524)	(0.481)
ln*LOCAL*	-0.65^{**}	-1.016^{*}
	(0.310)	(0.535)
ln*PHONE*	-126.62^{**}	-239.83^{**}
	(56.606)	(90.308)
$(\ln PHONE)^2$	14.070^{**}	26.909^{**}
	(6.355)	(9.929)
ln*QEA*	–0.158	0.914^{**}
	(0.130)	(0.433)
$\ln ACCESS_1$	-0.461^{**}	5.062^{**}
	(0.178)	(1.334)
$\ln ACCESS_2$	0.448	-5.437^{**}
	(0.401)	(1.347)
Observations	45	45
F-statistic	1213.67	550.89
R-Squared	0.9963	0.9742
Adjusted R-Squared	0.9955	0.9694

* Significant at the 10 % level
** Significant at the 5 % level.

Table 9:

First-stage Estimates:
Dependent variable Q_i/Q_j

Carrier = Dependent Variable	**AT&T** Q_1/Q_2	**OCC** Q_2/Q_1
Independent	Coefficient (Standard Error)	Coefficient (Standard Error)
INTERCEPT	−510.37	585.06*
	(450.13)	(307.47)
TIME	−.0001	0.039**
	(0.010)	(0.019)
ln*INCOME*	2.486**	−0.438
	(1.154)	(0.380)
ln*LOCAL*	3.419**	−0.667
	(1.690)	(0.557)
ln*PHONE*	791.66*	−258.12*
	(415.46)	(136.94)
$(\ln PHONE)^2$	−86.807*	28.769*
	(46.691)	(15.391)
ln*QEA*	−3.127**	0.393
	(0.935)	(0.308)
$\ln ACCESS_1$	−16.433**	2.113**
	(2.840)	(0.936)
$\ln ACCESS_2$	17.242**	−2.347**
	(2.868)	(0.945)
Observations	45	45
F-statistic	255.87	144.85
R-Squared	0.9850	0.9739
Adjusted R-Squared	0.9812	0.9671

* Significant at the 10 % level
** Significant at the 5 % level.

Appendix 2D

Ordinary Least Squares Estimates

In this appendix I present the regression results to the following reduced form equation:

$$\ln P_i = a_{i0} + a_{i1}EA + a_{i2}PC + a_{i3}DEREG + a_{i4}\ln ACCESS_i + u_i$$

where, *EA* equals the percentage of LEC access lines converted to equal access; *PC* and *DEREG* are dummy variables equal to one if AT&T is subject to price-cap regulation or rate deregulation, respectively, and zero otherwise; and $\ln ACCESS_i$ is the natural log of carrier *i*'s real average access fee for a 10 minute telephone call.

Table 10:
Ordinary Least Squares Estimates:

Carrier = Dependent Variable	**AT&T** $\ln P_1$	**OCC** $\ln P_2$
Independent	Coefficient (Standard Error)	Coefficient (Standard Error)
INTERCEPT	1.113**	1.135**
	(0.076)	(0.091)
EA	– 0.822**	– 0.414**
	(0.092)	(0.169)
PC	0.0048	– 0.047
	(0.022)	(0.212)
DEREG	0.054*	0.010*
	(0.032)	(0.0056)
$\ln ACCESS_i$	0.760**	0.686**
	(0.078)	(0.096)
Observations	45	45
F-statistic	665.45	461.01
R-Squared	0.9884	0.9834
Adjusted R-Squared	0.9869	0.9812

* Significant at the 10 % level
** Signifcant at the 5 % level.

Appendix 2E

Summary of Post-Divestiture Regulatory Activity

Table 11:
Post-Divestiture Timeline

1984	1985 - 1988	1989	1990	1991	1992	1993	1994	1995	1996*
January: Implementation of the Modified Final Judgment. AT&T divests its local Bell Operating Companies (BOCs). The BOCs are required to upgrade all of their local lines to "equal access" no later than Sept. 1986. Access charges required to replace the Separations and Settlements System. AT&T's rates still subject to rate-of-return regulation		**July**: FCC places AT&T's interstate rates under price-cap regulation. A price ceiling is imposed on 3 baskets of AT&T's services: (1) residential & small business services; (2) Toll free 800 services; and (3) large volume business services. Every July the ceiling on each basket is adjusted downward by 3%		**January**: FCC places LEC access fees under price-cap regulation. **October**: FCC deregulates rates for basket (3) long-distance services.		**May**: FCC deregulates rates for basket (2) long-distance services. **September**: AT&T files petition to be reclassified as "non-dominant."		**January**: FCC deregulates rates for small business basket (1) long-distance services. **October**: The FCC reclassifies AT&T as "non-dominant" and as a result eliminates all rate regulation of domestic interstate telephone service.	**February**: The 1996 Telecommunications Act is signed by President Clinton. **August**: FCC issues its local competition/inter-connection order. ILECs and several state PUCs immediately appeal. **October**: Court stays implementation of the FCC pricing standards (section 251) and "pick and choose" rule (section 252).

* Events subsequent to the 1996 Telecommunications Act are not directly examined in this paper.

Chapter Three

Regulatory Change and Its Impact on Long-Distance Prices and Market Power: The Intrastate Market

3.1 Introduction

During the years that have followed the AT&T divestiture, the telecommunications industry has experienced a regulatory environment with a greater willingness to implement alternative forms of regulation. In July 1989 the Federal Communications Commission (FCC) ceased regulating AT&T's interstate services under rate-of-return (ROR) regulation and implemented a pricing flexibility (PF) policy – price-cap regulation.[1] The subsequent, and most recent, change in the *rate* regulation of interstate long-distance services occurred in October 1995, when the FCC accepted AT&T's request to be reclassified as a "Non-Dominant" common carrier.[2,3] The outcome of this apparently innocuous reclassification was the deregulation of domestic rates for interstate long-distance service.[4]

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[1] Price-cap regulation was approved in May 1989 and implemented the following July. A description of standard price-cap regulation is provided in Section II. See Kridel, Sappington, and Weisman (1996) for a description of the various PF regulatory policies.

[2] The FCC's post-divestiture policy of regulating long-distance carriers is based on the 1979 *Competitive Carrier* rulemaking [77 F.C.C.2d 308 (1979)]. Under *Competitive Carrier* the FCC concluded that imposing the regulatory restrictions outlined in Title II of the Communications Act of 1934 on all long-distance carriers would inhibit, not promote, competition in this market. As a result the FCC established two categories of carrier: dominant common carrier and non-dominant common carrier. The former, which consisted of only AT&T, was subject to full FCC rate regulation, requiring a 90 day notice of a tariff filing. The latter were subject to streamlined FCC rate regulation, requiring a 14 day notice of a tariff filing.

[3] While numerous regulatory changes have occurred subsequent to the FCC's reclassification of AT&T (the most publicized being the 1996 Telecommunications Act), no rulemaking or legislation has directly altered the regulation of interstate long-distance *rates.*

[4] See Motion of AT&T Corp. to be Reclassified as a Non-Dominant Carrier, 11 FCC Rcd 3271, 3288, ¶26 (1995). The FCC still imposes rate averaging based on time of day, distance and duration. In addition, price-cap regulation is still maintained in the international telecommunications market.

Table 12:
Recent Changes in the Regulatory Policy of 36 Multi-LATA States (GA and WV excluded*), 1991-96

REGULATORY POLICY	YEAR 1991	1992	1993	1994	1995	1996
ROR Regulation	3	3	1	0	0	0
PF Regulation	21	18	15	13	12	11
Rate Deregulated	12	15	20	23	24	25

* Author was unable to determine the interLATA regulatory policy in GA and WV.

While the decision to implement PF regulation has taken time to develop in the interstate market, this has not been the case in many of the multi-LATA intrastate markets.[5] In 1988, when the FCC was first considering price-cap regulation, 28 of the 38 multi-LATA states had previously eliminated traditional ROR regulation,[6] and since then the intrastate long-distance markets have continued rapidly to reduce and eliminate rate regulation. For example, by 1991 only three multi-LATA states subjected AT&T to ROR regulation, and two years later, in 1993, all multi-LATA states had eliminated ROR regulation. Yet, what is most striking about the contemporary regulatory environment is the rapid pace at which states have deregulated their long-distance markets. In 1991, 11

[5] LATA, short for Local Access and Transport Area, is a geographic entity created at the time of divestiture as the demarcation boundary for the Regional Bell Operating Companies (RBOCs). Calls which cross the LATA boundary are referred to as interLATA calls, and must be passed off to a long-distance carrier. Intrastate interLATA calls are under the regulatory jurisdiction of the state Public Service Commissions (PSCs). Interstate interLATA calls are regulated at the federal level under the FCC.
[6] By January 1988, the following 28 states no longer imposed rate-of-return regulation: Alabama, Arizona, Florida, Georgia, Illinois, Kansas, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington, and West Virginia.

states had rate deregulated interLATA services;[7] by the end of 1996, the number of deregulated states had increased to 25 (See Table 12).[8]

It is the transition from a regulated to deregulated market environment that is examined in this paper. In particular, I employ annual observations on a panel of multi-LATA states from 1991-96 and compare the market conduct of the long-distance carriers in regulated markets to that in deregulated markets. My hypothesis is that elimination of rate regulation altered the carriers' market conduct, and this change in market conduct explains the price differences in regulated and deregulated markets. More formally, this is demonstrated by the following generalization of a monopolist's supply relation:[9]

$$P = MC - \theta QP'(Q) \tag{3.1}$$

where MC is marginal cost, θ is the market conduct parameter, and $P'(Q)$ is the slope of the inverse demand function. The conduct parameter θ is interpreted as an index measuring the competitiveness of firm conduct, where $0 \leq \theta \leq 1$. As θ moves farther from 0, market conduct moves farther from that of perfect competition. For example, $\theta = \frac{1}{N}$, where N is the number of symmetric firms in the market, is consistent with Cournot oligopoly; and $\theta = 1$ is consistent with monopoly.[10]

Two procedures are utilized to test the hypothesis of this paper. The first employs the complete time-series of panel data (1991-96). The objective is to estimate a market

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[7] The 11 states deregulated as of December 31, 1991 are the following: Arkansas, Idaho, Illinois, Iowa, Minnesota, Nebraska, North Dakota, Oklahoma, Oregon, Virginia, and Washington.
[8] The 14 states deregulated between 1992-96 are the following: California, Florida, Indiana, Kansas, Kentucky, Louisiana, Michigan, Missouri, Nevada, New Jersey, Ohio, Pennsylvania, Texas, and Wisconsin.
[9] A supply relation is derived from the first-order condition of a firm's profit function, with respect to the specified choice variable. In equation (1) the choice variable is assumed to be the firm's output Q.

supply relation similar to equation (3.1). To capture the impact of regulatory change on market conduct I introduce a linear approximation of θ that controls for regulatory change.[11] However, to derive a consistent estimate of the change in θ produced by rate deregulation I introduce three additional variables that may affect market conduct *and* be correlated with regulatory change. Thus, the four determinants of market conduct are defined as follows: (*i*) a dummy variable for states that are deregulated (1) or regulated (0); (*ii*) a market entry variable measuring the number of facility-based long-distance carriers competing in a state; (*iii*) a dummy variable for states that elect (1) or appoint (0) their commissioners; and (*iv*) a dummy variable for states that have eliminated (1) or retained (0) entry barriers into the adjacent *intraLATA* toll market. In particular, a single entry barrier is examined, that is, the technical ability to offer consumers "equal access" intraLATA toll service.[12]

The results indicate that, all things constant, deregulation increased the market conduct parameter (i.e., reduced the "competitiveness" of market behavior), resulting in a 4.6 percent increase in the market price. Among the political environment variables, the mandatory provision of "equal access" in the intraLATA toll market had a perverse impact on the interLATA market, that is, it increased the market conduct parameter, producing a 5.4 percent increase in the market price. Finally, an increase in the number

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[10] See Bresnahan (1989), p.1018.
[11] This approach is similar to Spiller and Favaro (1984), Gelfand and Spiller (1987) and Rubinovitz (1993).
[12] As its title suggests, intraLATA ***toll*** service is a long-distance service (i.e., customers are charged a per minute fee based on distance, duration, and time of day). Following divestiture the provision of intraLATA services were typically reserved exclusively to the local telephone company. As time progressed states permitted entry into the intraLATA toll markets, however, only on a non-equal access basis. It was not until 1995 that a small number of states permitted entry on an equal access basis.

Table 13:
A Matrix Description of the Regulatory Experiment Model

PERIOD	GROUP Treatment	Control
1 (1991-92)	Regulated	Deregulated
2 (1995-96)	Deregulated	Deregulated

of facility-based carriers competing in a market also had a positive impact on the market conduct parameter, resulting in a 7.83 percent increase in the market price.

The second procedure employs four years of the panel data set: 1991-92 and 1995-96. The objective is to reexamine the linear approximation of market conduct specified in the first procedure, namely, the assumption that θ is affected only by rate deregulation, two political environment variables, and a market entry variable. The concern is that unobserved factors are partially responsible for the change in market conduct that results when a state imposes regulatory change. To address this problem I exploit the regulatory "experiment" conducted by the states between 1991-96. This first entails disaggregating the cross-section of multi-LATA states into two ***groups***: a "control" group of states deregulated prior to the sample period; and a "treatment" group of states deregulated between 1993-94. Next, the years 1993-94 are used to separate four of the six years into two ***periods***: period one (1991-92) is comprised of a deregulated control group and a regulated treatment group; and period two (1995-96) is comprised of a deregulated control group and a deregulated treatment group (see Table 13). Based on this sample I compare the inter-period change in the treatment and control groups' market conduct to uncover and differentiate the influence of rate deregulation from that of changes in unobserved factors. Notice that while unobserved factors can, and likely do, have both a cross-sectional and time-series effect on the model, the procedure just described focuses only the latter effect. Unobserved cross-sectional variation, referred to as the state fixed effect, is controlled for by introducing state dummy variables, which I include in the model. Therefore, the objective of this procedure is to determine if unobserved changes in market structure occurred between 1993-94 and ascertain how (if at all) they distorted the estimated change in market conduct attributed to rate deregulation.

The procedure reveals that unobserved factors had a very small, positive but statistically significant, influence on the market conduct parameter resulting in a 0.73 percent increase in the treatment group's market price. This suggests the model employed in the first procedure sufficiently controls for the impact of structural change on market conduct. Of equal importance, the results from this "experiment" support the findings from the first procedure: the deregulatory treatment was determined to cause an increase in the treatment group's market conduct parameter, resulting in a 6.9 percent increase in the market price.

The remainder of the paper is organized as follows: Section 3.2 discusses some of the issues motivating the implementation of alternative regulation in the intrastate markets; Section 3.3 briefly reviews the literature on this topic and indicates the advantages of using contemporary data; Section 3.4 first describes the general model employed to estimate the change in market conduct that results from rate deregulation over the six year sample period. It then presents the regulatory experiment model. This includes a discussion of the criteria for selection of the treatment and control samples, as well as the methodology employed to distinguish the influence of the treatment from that of the unobserved factors; Section 3.5 is a discussion of the results; and section 3.6 states the conclusions.

3.2 State Motives for Implementing Alternative Regulation

By far the most popular PF regulatory policy implemented at the state level has been a variant of standard price-cap regulation (See Appendix 3A). Under standard price-cap regulation a price-ceiling is imposed, typically at the current ROR regulated price and adjusted periodically, based on changes in exogenous cost factors, such as the carrier's input costs and productivity improvements. In broad terms, the price-ceiling is set between regulatory hearings according to the formula:

$$CAP_t = (PPI_t - X)CAP_{t-1}$$

where, CAP_t is the price-ceiling, PPI_t is an index of producer prices, and X is a predetermined estimate of the change in the carrier's productivity.[13] Obtaining government approval to set a price above CAP_t involves filing a time-consuming and expensive rate case. Prices set at or below CAP_t, however, are generally effective after a brief notice period and subject to little regulatory oversight.

An important factor motivating the demise of ROR regulation has been the dramatic transformation of the telecommunications industry during the post-divestiture era. For example, the MFJ significantly altered the ownership structure and the regulated

[13] See Kwoka (1993) and Liston (1993).

interaction between the carriers in the telecommunications industry.[14] In addition, the rapid technological change that followed divestiture had a major impact on the method of long-distance transmission and the cost structure of the long-distance carriers.[15]

The response by many state regulators to this dynamic market environment was to replace the strict constraints of ROR regulation with a PF policy that endowed the regulated carrier with a (limited) ability to adjust its rates independent of regulatory approval. One of the rationales for PF regulation was that pricing flexibility would enable the regulated carrier to respond in a timely manner to unexpected changes in the market and thus promote efficient regulated firm behavior. However, it is important to recognize that reducing regulatory constraints provided only the ***ability*** to engage in competition, not necessarily the ***incentive*** to engage in competition. Given the unfavorable structural characteristics of the long-distance market – large sunk and fixed costs, a high market concentration, and a dominant firm controlling well over half the market – there was little expectation that the incentives to compete would be immediately forthcoming. Therefore, PF regulation was deemed an intermediate step that (*i*) enabled regulators to nurture the incentives of the carriers to compete, while (*ii*) protecting consumers from higher prices. It was typically assumed that the equilibrium monopoly price exceeded the existing ROR regulated price. Consequently, as the incentives to

[14] The MFJ had numerous implications for the industry. Some of the more salient aspects include the following: the divestiture of AT&T's RBOCs, the line of business restrictions imposed on AT&T and the RBOCs, the required upgrade of RBOC networks to enable *all* long-distance carriers to offer pre-subscribed service (also referred to as "1+" or "equal access" service). Coinciding with the implementation of the MFJ, the FCC reformulated the method by which access fees were paid by the long-distance carriers for access to the local telephone companies' networks.

[15] In the early 1980s, digital fiber optic transmission began replacing analog microwave and coaxial cable transmission. This conversion resulted in a dramatic increase in the capacity of the long-distance network and contributed to the volatility and variation the competing long-distance carriers' production costs.

compete developed under PF regulation one would expect to observe a convergence of the market price to its competitive level, followed by a transition to a deregulated environment.

3.3 Literature Review

Mathios and Rogers (M&R) (1989), and Kaestner and Kahn (K&K) (1990) investigated the impact of alternative forms of state regulation on the price of intrastate long-distance telephone service between 1986-88. The authors hypothesized that if the purpose of PF regulation was to restrict AT&T's market power, then the following two results should be found: (1) in states which had switched from ROR to PF regulation, there should not be an immediate change in the market price; and (2) in deregulated states, since AT&T is free to exercise its market power, an increase in the market price should be observed. The authors examined pricing behavior in three groups of intrastate interLATA markets: traditional ROR regulated markets, PF regulated markets, and deregulated markets. M&R employed a single cross-section of data on multi-LATA states in August 1986 and estimated a reduced form equation that was not explicitly derived from an underlying structural model of firm behavior. K&K examined a panel of multi-LATA states from 1986-88, and estimated a simultaneous system of equations derived from a specific market demand function and firm cost function. Both studies concluded that hypothesis (1) failed to hold. The conversion from ROR to PF regulation was found to result in a significant decrease in the market price.

Interestingly, the research failed to agree on the impact of converting from PF regulation to rate deregulation. K&K reported that the price of long-distance service in deregulated states was significantly lower than in PF regulated states. M&R reported that, even though the price in both deregulated and PF regulated states was significantly less than the price in ROR regulated states, deregulated states had significantly higher prices than PF regulated states. Although the former research provided further evidence that removing rate regulation would benefit long-distance consumers, the latter research contested this conclusion, suggesting that limited constraints on the dominant carrier might be beneficial to consumer welfare.

It is not entirely clear why the research reaches these opposing conclusions. While K&K reference M&R in their paper, they fail to reconcile their results with the earlier work. A possible explanation can be found in the authors' failure to control properly for the numerous structural changes that occurred in the years immediately following divestiture. Two important points follow from this observation. First, structural change may have produced measurement and specification error that is the cause of the authors' conflicting results. Second, by examining a later time period (1991-96), the present paper does not expose itself to these difficulties. In particular, the market structure in recent years has experienced relatively greater stability than in years past. I provide three examples to support this argument:

(1) Long-distance service has become a fairly homogenous product. Today, all of AT&T's competitors are provided "equal access" to the local exchange carriers' (LECs) networks.[16] This development has eliminated an important source of variation in the

[16] Equal access refers to a legal requirement imposed on the local telephone companies to offer comparable access interconnection to their networks for all long-distance carriers seeking such access by a certain date. Equal access allowed non-AT&T customers to access their long-distance company without dialing extra digits and therefore allowed AT&T's competitors to reduce the degree of product differentiation by introducing services that were comparable to AT&T's.

quality of long-distance service. The result is that the price premium for AT&T's service, which was prevalent throughout the 1980s, has today been largely eliminated.[17]

(2) The variation in the carriers' costs has diminished significantly since the 1980s. While the development of equal access removed much of the product differentiation in long-distance service, it also eliminated an important cost differential between carriers. Local telephone companies that persisted in offering non-equal access were required to charge a discounted access fee for their services ranging from 40-45 percent below the access fee for equal access service. Given that access fees account for approximately 40 percent of a long-distance carrier's total costs and a significantly higher percentage of its marginal costs, these discounts were an important source of variation in the carriers' costs of providing long-distance service.[18]

(3) Completion of the long-distance carriers' conversion to fiber optic transmission technology has both reduced the variation in carrier costs *and* stabilized the cost structure of the facility-based carriers. In the early 1980s, there was a significant change in the production of long-distance telephone service as (low marginal cost) fiber optic technology replaced the pre-existing (high marginal cost) microwave and coaxial cable technology. The facility-based carriers' investment in fiber optic glass was robust throughout the 1980s, and as a result it increased the variation in costs both across carriers and over time. For example, conversion of the long-distance network to fiber

[17] See MacAvoy (1996) and Ward (1996).
[18] Ward (1996) cites access fees at 40% of total cost (p.3), while Kaestner and Kahn (1990) state that access fees "represent more than 50% of AT&T's marginal costs (p. 366)."

optics was not instantaneous but ongoing throughout the 1980s. In addition, network upgrades were undertaken at a different pace by the facility-based carriers.[19]

Therefore, for the purposes of this study, the contemporary sample from 1991-96 has advantages over the earlier period examined in M&R and K&K in that it is better suited to addressing the impact of regulatory change. The homogeneity of long-distance service and the reduced variation in production costs have diminished the variation in the carriers' demand and supply behavior. In turn, this reduces the possible sources of specification and measurement error, which may explain the discrepancy in the prior research results.

3.4 A Model of Market Demand and Conduct

This section consists of two parts. Part A is a description of the general model employed to estimate the change in market conduct caused by rate deregulation over the six year sample period. Part B presents the regulatory experiment model.

A. The General Model

To determine the impact of rate deregulation on market conduct of the long-distance carriers this paper examines a static oligopoly model which does not require the econometrician to observe *all* of the components of a firm's cost function. Instead, a

[19] Per the FCC's *Fiber Deployment Update* (1997) -Table 2, throughout the 1980s AT&T's expansion of its fiber network was dramatic, yet fairly constant. However, in the 1990s there was a significant decline in AT&T's investment in fiber optics. For example, AT&T added 432,000 fiber route miles between 1985-87, 504,000 fiber route miles between 1988-90, 120,000 fiber route miles between 1991-93, and 117,000 fiber route miles between 1994-96. In contrast, Sprints investment in its fiber network was much more instantaneous and, for the most part, non-existent in the 1990s. For example, Sprint added 449,500 fiber

carrier's marginal cost is inferred from the observed changes in the equilibrium outcome.[20] The model is derived from a firm's first-order condition, or supply relation,

$$P_{st} = MC_{ist}\left(q_{ist}, Z_{st}, \Gamma\right) - \lambda q_{ist} P_{st}'\left(Q_{st}, Y_{st}, \delta\right) \tag{3.2}$$

where, i is the firm subscript, s indicates the market (in our case a state), and t is the time period. The variables in equation (3.2) are defined as follows:

P_{st}	= the market price;
$MC_{ist}(*)$	= firm i's marginal cost function;
q_{ist}	= firm i's output;
Z_{st}	= vector of exogenous cost shift variables;
Γ	= unknown parameters of the marginal cost function;
λ	= the firm specific market conduct parameter;
$P_{st}'(*)$	= first derivative of the inverse market demand function, with respect to Q_{st};
Q_{st}	= aggregate output;
Y_{st}	= vector of exogenous demand shift variables; and
δ	= unknown parameters of the inverse market demand function.

The parameter λ measures an individual firm's market conduct, where $\lambda \geq 0$. If $\lambda = 0$ price equals marginal cost and conduct is consistent with perfect competition. $\lambda = 1$ is consistent with Cournot conduct, and joint profit maximizing conduct is identified whenever $\lambda = N$, where N is the number of firms in the industry. Since this paper employs data at the market level, I proceed by summing equations (3.2) over the N firms, yielding

$$NP_{st} = \sum_{i=1}^{N} MC_{ist}\left(q_{ist}, Z_{st}, \Gamma\right) - \lambda Q_{st} P_{st}'\left(Q_{st}, Y_{st}, \delta\right) \tag{3.3}$$

route miles between 1985-87, 17,000 fiber route miles between 1988-90, 500 fiber route miles between 1991-93, and 1,500 fiber route miles between 1994-96.

[20] See Bresnahan (1989) for a survey of this "New Empirical Industrial Organization" (NEIO) methodology.

Next, I assume symmetry of the individual firms' marginal cost functions to derive the market average supply relation:

$$P_{st} = MC_{st}\left(Q_{st}, Z_{st}, \Gamma\right) - \theta Q_{st} P_{st}'\left(Q_{st}, Y_{st}, \delta\right) \qquad (3.4)$$

which can be estimated with the industry-level data that are publicly available. Before proceeding I provide a justification for, and an interpretation of, the market supply relation. The assumption of symmetric marginal costs across carriers can be justified given the uniformity of input costs across carriers. For example, the cost of access to the local exchange network – or "access fee" – is strictly regulated by each states' PSC. Variation in access fees across carriers occurs primarily due to the type of access. However, as of 1991 non-equal access service comprised only a small percentage of the market.[21] In addition, non-executive labor in the telecommunications industry is highly unionized and there is little variation in the union influenced wage across carriers. The interpretation of θ is the following: $\theta \equiv \lambda/N$, therefore $0 \leq \theta \leq 1$; perfect competition is consistent with $\theta = 0$, Cournot behavior is implied when $\theta = 1/N$, and joint profit maximizing behavior occurs when $\theta = 1$. Finally, it should not be construed from equation (3.4) that the firms necessarily have identical equilibrium conduct. Instead θ should be treated as the average firm conduct in an intrastate market.

In the standard application of an NEIO model the supply relation and demand function are estimated simultaneously. To accomplish this end a functional form is

[21] For the 36 states examined in this paper the 1991 annual average market share of non-equal access service was 8 percent [Max = 29.5% (MT-US West), Min = 0.3 (WI-Ameritech)]. See FCC, *Statistics of Communications Common Carriers* (1991-97), Table 2.3.

specified for the inverse market demand and marginal cost function. In addition, to capture the impact of regulatory change on market conduct a function is specified indicating the possible determinants of conduct.

I begin with the specification of the market conduct equation. The linear approximation of market conduct is assumed to take the following form:

$$\theta = \theta_0 + \theta_1 DEREG_{st} + \theta_2 EA_{st} + \theta_3 ELECT_{st} + \theta_4 IXC_{st} \qquad (3.5)$$

where, $DEREG_{st}$, equals one if state s is deregulated in period t, and zero otherwise; the first political environment dummy variable EA_{st} equals one if state s permits "equal access" competition in the *intraLATA* toll market in period t and 0 otherwise; the second political environment variable $ELECT_{st}$ equals one if state s elects its public service commissioners in period t and zero otherwise; the market entry variable, IXC_{st}, measures the number of facility-based carriers that provide long-distance service in state s and period t; θ_0 is the baseline market conduct parameter, measuring the effectiveness of rate regulation in influencing the market outcome; θ_1 measures the change in market conduct attributed to rate deregulation; θ_2 and θ_3 measure the change in market conduct attributed to a change in the political environment of the PSC; and θ_4 measures the change in market conduct attributed to the entry of a facility-based carrier.

There are no hypotheses imposed on the coefficients on $DEREG_{st}$ and IXC_{st}. While rate deregulation and the development of market entry would both be negatively correlated with the market conduct variable in a non-cooperative oligopoly market (H_0: $\theta_1 \leq 0$, $\theta_4 \leq 0$), such predictions would not necessarily hold in a collusive market environment. However, with regards to IXC_{st} a positive correlation (H_0: $\theta_4 > 0$) is suggested by results found in previous research. For example, Kaestner and Kahn (1990) regress non-AT&T market share on AT&T's intrastate MTS rates and discover a positive, statistically significant correlation between the variables. In MacAvoy's (1995) study of the interstate market, he regresses the weighted average Lerner index of AT&T, MCI, and Sprint on the Herfindahl index of market concentration and discovers a negative relationship between market power and concentration.[22] Therefore, if we assume that market entry by facility-based carriers produces a significant reduction in market concentration then a finding of $\theta_4 > 0$ would be consistent with prior research.

The hypothesis for the coefficient on EA_{st} is $\theta_2 > 0$. This prediction is based on the assumption that entry deregulation in the adjacent *intraLATA* toll market informs long-distance carriers of a change in PSC attitude towards (or acquiescence to) market deregulation. Accordingly, it reduces the probability that regulators will reintervene in deregulated markets or impose stricter constraints on market conduct in regulated markets. The end result being that it enables the long-distance carriers to exercise more effectively market power in their core interLATA market.

Finally, the predicted coefficient on $ELECT_{st}$ is based on a rent-seeking theory of economic regulation.[23] The hypothesis is that the political support applied by consumer interests is greater in those states that elect (as opposed to appoint) their commissioners. Thus, a utility maximizing elected regulator will take greater effort, than an appointed

[22] Firm i's Lerner index $\mathcal{L}_i \equiv (P_i - MC_i)/P_i$, where P_i and MC_i are firm i's price and marginal cost respectively. The Herfindahl index is defined as $H = \sum_{i=1}^{I} MS_i^2$, where MS_i is the market share of the ith firm in a market comprised of I firms.

regulator, to serve consumer interests. If we assume that regulators influence market conduct and consumers favor low rates then the expected coefficient on $ELECT_{st}$ is $\theta_3<0$.

Next, I specify the functional forms imposed on the inverse demand and marginal cost functions. A log-linear function is assumed for both and specified as follows:

Inverse Demand

$$\ln P_{st} = \delta_0 + \delta_1 \ln Q_{st} + \delta_2 \ln PHONE_{st} + \delta_3 \ln INCOME_{st} + \delta_4 \ln UNEMPLOY_{st} + \sum_{s=1}^{S=35} \mu_s STATE_s + \varepsilon_{dst} \quad (3.6)$$

where, $STATE_S$ is a dummy variable equal to one if observation s is of state s, and 0 otherwise (WI is the excluded state dummy). The purpose for including $STATE_S$ is to account for possible correlation in the residuals within a state across time, that is the state fixed effect. The exogenous demand shift variables are defined as follows: ln*PHONE* is the natural log of the percentage of total households that subscribe to local telephone service. An increase in subscribership should increase the demand for long-distance service. ln*INCOME* is the natural log of per capita personal income. Given that long-distance telephone service is considered a normal good, we expect that as a customer's income rises this will have a positive effect on market demand. ln*UNEMPLOY* is the natural log of the state unemployment rate. As the unemployment rate rises we should expect the demand for long-distance service to decline. See Table 14 for the summary statistics of these variables and their data sources.

[23] See Stigler (1971), Posner (1974), and Peltzman (1976).

The assumption of a log-linear inverse demand function is consistent with other empirical studies of the interLATA market.[24] Given this functional form, the partial derivative with respect to Q_{St} is $P'_{st}(Q_{st}, Y_{st}, \delta) = \delta_1 (P_{st}/Q_{st})$.

Marginal Cost

$$\ln MC_{st} = \Gamma_0 + \Gamma_1 \ln ACCESS_{st} + \varepsilon_{cst} \qquad (3.7)$$

The exogenous cost shift variable $\ln ACCESS_{St}$ is the natural log of the average access fee long-distance carriers pay to the Regional Bell Operating Companies (RBOCs) for a 10 minute telephone call. Access to the local network is the predominant input required for the production of long-distance service. Access fees generally account for approximately 40% of a firm's total costs and an even higher percentage of its marginal costs. Therefore, we would expect an increase in the price of this input to have a positive impact on the market price. See Table 14 for the variables, summary statistics, and data source.

The assumption that marginal cost is independent of the market output appears reasonable given the characteristics of fiber optic transmission technology and the significant excess capacity of the facilities based long-distance carriers.[25] The assumption of a log-linear functional form is consistent with other empirical studies of the interLATA

[24] See Ward (1995), Gatto, Kelejian, and Stephan (1988), and Gatto, et. al. (1988). The choice of a log-linear functional form was supported by utilizing MacKinnon, White, and Davidson's (1983) P_E test. While the linear specification was rejected by both the full sample and the pooled control and treatment sample, the log-linear specification was not rejected by either sample.

[25] As of December 31, 1996 only 53.1% of AT&T fiber optic network was "lit," that is, connected to AT&T switches and capable of transmitting a telephone call. The other facilities based long-distance carriers have similar excess capacity. See Kraushaar (1997).

Table 14:
Variable Names, Definitions, and Descriptive Statistics

Variable	Definition	Mean		Standard Deviation	Source
ln*P*	Natural log of AT&T's tariffed price for a daytime, 56-124 mile, 10 minute intrastate Message Toll Service (MTS) telephone call.*		0.890	0.200	a
		Control =	0.958	0.210	
		Treatment =	0.880	0.207	
ln*Q*	Natural log of billed access minutes to the local exchange network (in thousands).+		14.36	1.171	b
		Control =	13.85	0.989	
		Treatment =	14.87	1.387	
ln*PHONE*	Natural log of the percentage of households subscribing to local telephone service.		– 0.065	0.027	c
		Control =	– 0.058	0.029	
		Treatment =	– 0.064	0.023	
ln*INCOME*	Natural log of per capita personal income.		9.927	0.256	d
		Control =	9.901	0.240	
		Treatment =	9.933	0.214	
ln*UN-EMPLOY*	Natural log of the state unemployment rate.		– 2.861	0.449	e
		Control =	– 2.990	0.488	
		Treatment =	– 2.799	0.416	
ln$ACCESS_i$	Natural log of the average access fee long-distance carriers pay to the RBOCs for a 10 minute telephone call.^		0.108	0.396	f
		Control =	0.211	0.434	
		Treatment =	– 0.002	0.334	
DEREG	Dummy variable equal to one if state s is deregulated in period t, zero otherwise.		0.551	0.499	g
EA	Dummy variable equal to one if state s permits "equal access" competition in the *intraLATA* toll market in period t, zero otherwise.		0.028	0.165	g
		Control =	0.030	0.173	
		Treatment =	0.030	0.173	
ELECT	Dummy variable equal to one if state s elects its public service commissioners in period t, zero if commissioners are appointed.		0.222	0.417	g
		Control =	0.273	0.449	
		Treatment =	0.091	0.289	
IXC	The number of facility-based carriers that offer long-distance service.		6.379	2.665	g
		Control =	6.969	2.817	
		Treatment =	6.671	2.582	

Sources: (**a**) Tariffed MTS rates are filed with the state Public Service Commissions; (**b**) FCC, *ARMIS 4308 – Annual Operating Statistics and Access Line Data* (annual reports from 1991-96), Table IV; (**c**) FCC, Industry Analysis Division, *Telephone Subscribership in the U.S.* (1997); (**d**) U.S. Department of Commerce, Bureau of Economic Analysis, *State Personal Income Report*; (**e**) U.S. Department of Labor, Bureau of Labor Statistics; (**f**) FCC, *ARMIS 4308* and *ARMIS 4301 – Quarterly Financial and Demand Data* (4th quarter reports from 1991-96); and (**g**) NARUC, *Utility Regulatory Policy in the U.S. and Canada* (1990-96) and phone survey of commissions.

Notes: * MTS is a switched service (i.e., originates and terminates on a LEC's local network), used primarily by small businesses and households. The mileage band range 56-124 was chosen because it was the most popular mileage band used by state PSCs (14 of 36). For states that classified MTS prices according to a different mileage band, a weighted price was calculated that corresponded to a 56-124 mile call. See Mathios and Rogers (1989) for a similar treatment of mileage band variation.

+ Billed access minutes (BAMs) are compiled by the local telephone companies and are based on the bills they issue to the long-distance carriers for access to the local network. BAMs only include minutes of switched interLATA service on a minute-of-use basis. In particular, BAMs do not include special access services (i.e., "service bypass") which employ dedicated circuits leased from the local telephone companies. BAMs also do not include long-distance service provided over leased or purchased facilities not owned by the local telephone company (i.e., "facilities bypass").

^ Access fees are charged on a per minute basis and consist of four components: (1) an originating carrier common line fee; (2) a terminating carrier common line fee; (3) a traffic sensitive fee; and (4) a non-traffic sensitive fee.

market.[26]

To derive the market supply relation substitute into equation (3.4) the determinants of market conduct as specified in equation (3.5), the partial derivative from the inverse demand equation (3.6) and the marginal cost equation (3.7). As in the inverse demand function, state dummy variables are included to control for possible correlation in the residuals across states. Taking the natural log of both sides of the equation produces the following:

$$\begin{aligned} \ln P_{st} = & -\ln\left[1 + \left(\theta_0\delta_1 + \theta_1\delta_1 DEREG_{st} + \theta_2\delta_1 EA_{st} + \theta_3\delta_1 ELECT_{st} + \theta_4\delta_1 IXC_{st}\right)\right] \\ & + \Gamma_0 + \Gamma_1 \ln ACCESS_{st} + \sum_{s=1}^{S=35} \beta_s STATE_s + \varepsilon_{cst} \end{aligned} \tag{3.8}$$

Equation (3.8) can be further simplified by taking a linear approximation of the natural log function. Note that $y = \ln[1+x] \cong x$, for the small values of x which are found in this study.[27] Imposing this approximation removes the non-linearity of equation (3.8) and results in the following:

$$\begin{aligned} \ln P_{st} = & -\theta_0\delta_1 - \theta_1\delta_1 DEREG_{st} - \theta_2\delta_1 EA_{st} - \theta_3\delta_1 ELECT_{st} - \theta_4\delta_1 IXC_{st} \\ & + \Gamma_0 + \Gamma_1 \ln ACCESS_{st} + \sum_{s=1}^{S=35} \beta_s STATE_s + \varepsilon_{cst} \end{aligned} \tag{3.9}$$

Therefore, the general model consists of a system of two equations as specified by the inverse market demand (3.6) and the market supply relation (3.9).

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[26] In Ward's (1995) study of the intrastate interLATA market he estimated a log-linear supply relation that imposed a log-linear marginal cost function. The dependent variable in the supply relation was an index of the price of MTS and the estimated coefficient on output in the supply relation was insignificant. In addition, Kaestner and Kahn's (1990) supply relation was log-linear, while Mathios and Rogers' (1989) reduced form equation was also log-linear.

[27] A non-linear regression was performed on equation (3.8) and the results reported in appendix 3B. The magnitude of the coefficients estimates are similar and the results are unchanged. Given the simplified interpretation and analysis of the linear model, the results reported in the body of the paper are from the linear regression of equation (3.9).

B. The Regulatory Experiment Model

Notice equation (3.5) assumes that only four variables influence market conduct: rate deregulation, two political environment variables, and a market entry variable. In this section a unique approach is taken to determine whether the linear approximation of market conduct is properly specified. The objective is to address the following questions: Are there additional, possibly unobserved, variables that influence market conduct and are excluded from equation (3.5)? And if so, how does their inclusion alter the results previously derived?

Three examples of unobserved factors are provided. First, even at the present time no state has completely deregulated intrastate long-distance service. Generally, the states that have ceased regulating rates still have an influence on the market environment by requiring statewide uniform pricing (i.e., no geographic de-averaging) and imposing limited reporting requirements. This suggests that while regulatory oversight plays an explicit role in regulated markets, as reflected in the regulatory statutes, it appears also to play an implicit role in both regulated and deregulated markets, as reflected by the attitudes of state regulators and their interpretations of the market environment. Changes in these attitudes and interpretations could alter market conduct. Unfortunately, such changes are difficult to measure and often unobserved. Second, during the sample period there have been numerous actual, and anticipated, changes in FCC and state regulation that indirectly affected the intrastate long-distance market.[28] This deals with the influence

[28] For example, the FCC deregulated interstate long-distance services to high volume business consumers in October 1992, and deregulated interstate 800 services (excluding 800 directory services) in May 1993. In 1994 Congress began deliberations in what would eventually result in the 1996 Telecommunications Act. Finally, in 1994 a small number of states began examining whether to permit 1+ competition in their intraLATA toll markets.

of multi-market contact on market conduct, which one could argue is partially controlled for in the model by EA_{st}. However, given the multitude of markets in which the long-distance carriers compete EA_{st} may be an insufficient control for multi-market contact. Finally, the flow of information between the carriers may have improved during the sample period as a result of the convergence and stabilization of the carriers' production costs in the late 1980s. A change in the flow of information between carriers could have an influence on their market conduct.

In deriving the regulatory experiment model I begin by disaggregating the cross-section of states into two ***groups***: a "control" group of states deregulated prior to the sample period; and a "treatment" group of states deregulated in 1993 or 1994. Next, the years 1993-94 are used to separate the panel data set into two ***periods***: period one (1991-92) is comprised of a deregulated control group and a regulated treatment group; and period two (1995-96) is comprised of a deregulated control group and a deregulated treatment group (see Table 13).

The purpose for defining two time periods is to compare the inter-period change in the treatment and control group's market conduct. Since the control group has previously experienced rate deregulation, the inter-period change in this group's market conduct, controlling for *ELECT*, *EA*, and *IXC*, must be attributed to unobserved factors. However, the inter-period change in the treatment group's market conduct is subject to both the deregulatory treatment and unobserved factors. To utilize the information provided by the control group, the impact of unobserved factors on market conduct is assumed constant across the groups and uncorrelated with the treatment. From this a comparison of the inter-period change in market conduct in control and treatment groups uncovers and differentiates the influence of rate deregulation from that of the unobserved effects.

The sample employed in the regulatory experiment model differs in two respects from that utilized in the general model. First, as previously described, the regulatory experiment excludes two of the six years of the panel. Such an adjustment is necessary to acquire a treatment group of sufficient size; that is, the compilation of a time-series of treatment states that corresponded with the time-series of the control states required expanding the inter-period interval to two years. Second, the cross section of states in the regulatory experiment is a subset of the cross-section utilized in the general model. This occurs because not all of the multi-LATA states qualified for inclusion in the "experiment." For example, 10 states that retained regulation for the duration of the sample period were excluded.[29] In addition, 4 states that were deregulated during the sample period but not at the specified inter-period interval were also excluded.[30] Therefore, the treatment group consists of annual observations on 11 states for four years - 1991, 1992, 1995, and 1996;[31] the control group, coincidentally, also consists of 11 states and the same four years.[32]

The linear approximation of market conduct required a slight modification of equation (3.5) and is specified as

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[29] The 10 states that retained regulation for the duration of the sample period are the following: Arizona, Colorado, Maryland, Massachusetts, Mississippi, Montana, New York, North Carolina, South Carolina, and Tennessee.

[30] Three states were deregulated in 1992: Indiana, Michigan, and New Jersey. Alabama was reregulated in 1995.

[31] The treatment group of states deregulated between 1993-94 are the following: California, Florida, Kansas, Kentucky, Louisiana, Missouri, Nevada, Ohio, Pennsylvania, Texas, and Wisconsin.

[32] The control group of states deregulated prior to 1991 are the following: Arkansas, Idaho, Illinois, Iowa, Minnesota, Nebraska, North Dakota, Oklahoma, Oregon, Virginia, and Washington.

$$\theta = \theta_0 + (\theta_1 + \alpha_1)TIME_t + \theta_2 EA_{st} + \theta_3 ELECT_{st} + \theta_4 IXC_{st} \tag{3.10}$$

where α_1 is the change in market conduct attributed to unobserved factors, and $TIME_t$ is a dummy variable equal to one for period two observations and zero for period one observations. The coefficient on $TIME_t$ states that market conduct in period two is affected by deregulation of the treatment group (θ_1) as well as a change in unobserved factors (α_1). Recognize that by definition $\theta_1 = 0$ for the control group, since it experienced no inter-period change in rate regulation.

For efficiency reasons, the treatment and control samples are combined and estimated in a single regression equation. In addition, a number of linear restrictions are tested to determine if the supply and demand coefficients are equal across groups. In Section V I discuss the restricted regression results. However, in the following discussion I present the unrestricted model and list each group's demand and supply relation equations separately.

The control and treatment supply relations are identical to equation (3.9), except that market conduct is respecified according to equation (3.10). The supply relations are listed below. Note that superscripts are added to distinguish between the treatment (T) and control (C) groups.

<u>Control Group</u>

$$\begin{aligned} \ln P_{st} = & -\theta_0^C \delta_1^C - \alpha_1 \delta_1^C TIME_t - \theta_2^C \delta_1^C EA_{st} - \theta_3^C \delta_1^C ELECT_{st} - \theta_4^C \delta_1^C IXC_{st} \\ & + \Gamma_0^C + \Gamma_1^C \ln ACCESS_{st} + \sum_{s=1}^{S=10} \beta_s^C STATE_s + \varepsilon_{cst} \end{aligned} \tag{3.11-C}$$

Treatment Group

$$\ln P_{st} = -\theta_0^T \delta_1^T - \left(\theta_1^T + \alpha_1\right)\delta_1^T TIME_t - \theta_2^T \delta_1^T EA_{st} - \theta_3^T \delta_1^T ELECT_{st} - \theta_4^T \delta_1^T IXC_{st}$$
$$+\Gamma_0^T + \Gamma_1^T \ln ACCESS_{st} + \sum_{s=1}^{S=10} \beta_s^T STATE_s + \varepsilon_{cst} \qquad (3.11\text{-T})$$

By failing to include a group superscript on α_I I impose the assumption that unobserved effects are identical across groups. In the deregulated control group, θ_1^C is by definition zero and dropped from the control group supply relation. Thus, the coefficient on $TIME_t$ in equation (3.11-C), $\alpha_1\delta_1^C$, measures the change in market conduct between periods one and two attributed to a change in unobserved factors (α_I) interacted with the control group's demand elasticity (δ_1^C). The treatment group is subject to both rate deregulation and unobserved effects and, accordingly, the coefficient on $TIME_t$ in equation (3.11-T), $\left(\theta_1^T + \alpha_1\right)\delta_1^T$, measures the change in market conduct between periods one and two attributed to deregulation (θ_1^T) and unobserved factors (α_I), interacted with the treatment group's demand elasticity (δ_1^T).

The inverse demand equations are identical to equation (3.4) except that superscripts are added to the coefficients to distinguish between the treatment(T) and control(C) groups.

Control Group

$$\ln P_{st} = \delta_0^c + \delta_1^c \ln Q_{st} + \delta_2^c \ln PHONE_{st} + \delta_3^c \ln INCOME_{st}$$
$$+\delta_4^c \ln UNEMPLOY_{st} + \sum_{s=1}^{S=10} \mu_s^C STATE_s + \varepsilon_{dst} \qquad (3.12\text{-C})$$

Treatment Group

$$\ln P_{st} = \delta_0^T + \delta_1^T \ln Q_{st} + \delta_2^T \ln PHONE_{st} + \delta_3^T \ln INCOME_{st} + \delta_4^T \ln UNEMPLOY_{st} + \sum_{s=1}^{S=10} \mu_s^T STATE_s + \varepsilon_{dst} \qquad (3.12\text{-T})$$

The hypothesis I wish to test is whether rate regulation restricted market conduct. The formal statement of this hypothesis is the following:

$$H_0: \quad \theta_1^T > 0$$

$$H_1: \quad \theta_1^T \leq 0$$

For H_0 to be valid, there must be a positive inter-period change in the treatment group's market conduct attributed to rate deregulation. However, interest lies not only in the sign of this expression, but also its magnitude and the its subsequent impact on the market price. These issues are discussed below.

First, I examine the coefficient estimate on $TIME_t$ in the treatment group's supply relation equation (3.11-T): $\overline{(\theta_1^T + \alpha_1)\delta_1}^T$.[33] An estimate of demand elasticity $\overline{\delta}_1^T$ is attained from the inverse market demand function, and

$$\overline{\theta_1^T + \alpha_1} = \frac{\overline{(\theta_1^T + \alpha_1)\delta_1}^T}{\overline{\delta}_1^T} \qquad (3.13)$$

However, from the estimate derived in (3.13) one cannot distinguish $\overline{\theta}_1^T$ from $\overline{\alpha}_1$. To address this problem I take advantage of the information provided by the control group plus the assumption that α_1 is constant across groups. The coefficient on $TIME_t$ in equation (3.11-C) is the following: $\overline{\alpha_1\delta_1}^C$. An estimate of the demand elasticity $\overline{\delta}_1^C$ is

[33] The bar over the variable and those that follow indicate an estimate.

attained from the control group's inverse market demand function and, accordingly, α_1 is estimated as follows:

$$\bar{\alpha}_1 = \frac{\overline{\alpha_1 \delta_1}^C}{\bar{\delta}_1^C} \tag{3.14}$$

Finally, a "difference-in-difference" estimator[34] is employed to uncover the estimate of θ_1^T, which is calculated by taking the difference of the treatment and control groups' inter-period differences in market conduct,

$$\bar{\theta}_1^T = \overline{\theta_1^T + \alpha_1} - \bar{\alpha}_1 \tag{3.15}$$

Derivation of the standard errors of the estimates derived in equations (3.13)-(3.15) requires estimation of the demand and supply equations as a system. From this an estimate of the system covariance matrix is produced, and in conjunction with the Delta method, the standard errors are derived.[35]

3.5 The Empirical Results

Six years of data are collected on 36 of the 38 multi-LATA states at annual frequencies from 1991 to 1996.[36] The general model utilizes all 216 observations of the panel data (T=6, S=36) and is comprised of two equations: (3.6) and (3.9). The regulatory experiment model employs four years of data on a cross-section of 22 states,

[34] The application of a "difference-in-difference" estimator to uncover variation between a treatment and control sample has typically been utilized in the labor economics literature. See Gruber (1994), Card and Krueger (1995), and Madrian (1994).
[35] See Greene (1993), p.297 for a description of the Delta method.
[36] Two states, Georgia and West Virginia, were excluded from the sample since the author was unable to determine these states' long-distance regulatory policy.

or 88 observations (T=4, S=22), and is comprised of four equations: (3.11-C), (3.12-C), (3.11-T), and (3.12-T).[37]

Table 15 presents the results from estimation of the log-linear demand equations. Column two lists the demand results from the general model. Columns three and four list the restricted demand results from the regulatory experiment model. Where a single number is listed in the third and fourth column, the variable is restricted to having the same impact across groups.[38] Given that the market price and output are determined simultaneously, estimation of the inverse demand functions with ordinary least squares would produce inconsistent and biased coefficient estimates. Accordingly, I utilize a two-stage least squares regression procedure. The primary purpose for regressing demand is to obtain estimates of the coefficients on lnQ_t: $\overline{\delta}_1, \overline{\delta}_1^T$ and $\overline{\delta}_1^C$. These coefficients are then used to estimate the determinants of market conduct and the unobserved effect.

Inverting the coefficient on lnQ_t provides a measure of the price elasticity of demand. The estimated elasticities are -0.742 for the full sample regression, -0.835 for the control group, and -0.654 for the treatment group. In light of previous empirical research on demand for long-distance service, the estimated elasticities are reasonable.[39]

[37] Note that for estimation purposes the four treatment and control equations are combined into two equations [(3.9-C)+(3.9-T)=(3.9) and (3.10-C)+(3.10-T)=(3.10)]. The two equations are estimated with the pooled sample consisting of both groups.

[38] In the first "stage" I estimated the unrestricted inverse demand function and performed joint hypothesis tests on each pair of treatment and control coefficients. In the second "stage" I estimated the restricted inverse demand function, where the paired coefficients that failed to reject equality across groups were restricted to a single coefficient estimate. For the paired coefficients that rejected equality across groups no restrictions were placed on the coefficients.

[39] See Ward (1995), p.38, Kahai, et. al. (1996), p.509 and Taylor (1994).

Table 15
Two Stage Least Squares Estimates: Inverse Demand Function
Dependent Variable: $\ln P_t$
(t-statistics in parentheses)

	The General Model *Full Sample* (S=36, T=6)	*Control Group** (S=11, T=4)	The Regulatory Experiment Model	*Treatment Group*** (S=11, T=4)
INTERCEPT	2.291 (.503)		.2704 (.0826)	
ln*Q*	-1.348 (-2.664)	-1.197 (-2.131)		-1.528 (-2.205)
ln*PHONE*	-.177 (-.195)		1.120 (.922)	
ln*INCOME*	1.226 (18.512)		1.574 (2.731)	
ln*UNEMPLOY*	-.1592 (-2.47)		-.1269 (-1.993)	
STATE DUMMY VARIABLES	YES		YES	
F-statistic	1048.58		2186.22	
R-Squared	.9957		.9962	
Adj. R-Squared	.9948		.9958	
Instrument:	ln*ACCESS*		ln*ACCESS*	

*Control Group States –
1) AR, 2) ID, 3) IL, 4) IA, 5) MN, 6) NE, 7) ND, 8) OK, 9) OR, 10) VA, and 11) WA.
**Treatment Group States –
1) CA, 2) FL, 3) KA, 4) KY, 5) LA, 6) MT, 7) NV, 8) OH, 9) PA, 10) TX, and 11) WI.

The estimated coefficients on the remaining independent variables in the demand equations, with one exception, have their expected signs and are significant. The coefficient estimate on *lnINCOME* is 1.23 for the full sample regression. In the pooled control and treatment regression the restricted coefficient estimate is 1.57. These results conform with the expected income effect on a normal good. The estimated coefficient on state unemployment rate *lnUNEMPLOY* is -.159 for the full sample and for the pooled treatment and control sample it is -.127. These results agree with the hypothesized impact of unemployment on demand. Finally, the variable measuring the number of households that subscribe to local service *lnPHONE* has a coefficient estimate of -.177 for the full sample, and for the pooled sample the restricted coefficient estimate is 1.12. Neither of these point estimates are statistically significant. A more broadly defined statistic is collected by the FCC measuring households with *access* to telephone service. Similar results were found when this measure was used in place of *lnPHONE*. For all states in the sample *lnPHONE* was stable (stand. deviation = 0.024) with a slight upward trend (average annual percentage change = 0.1) and in only three states did it drop below 90 percent (AR, AL, MS). This suggests that a possible explanation may be the success of "universal service," that is, the variation in *lnPHONE*, across states and over time, represents primarily transitory shocks which do not significantly affect demand.

Table 16 presents the results from estimation of the supply relation equations. Column two lists the supply relation results from the general model. Columns three and four list the restricted supply relation results from the regulatory experiment model. Where a single number is listed in the third and fourth column, the variable is restricted to

Table 16
Two Stage Least Squares Estimates: Supply Relation
Dependent Variable: $\ln P_t$
(t-statistics in parentheses)

	The General Model *Full Sample* (S=36, T=6)	*Control Group* (S=11, T=4)	The Regulatory Experiment Model	*Treatment Group* (S=11, T=4)
INTERCEPT	.5363 (3.936)		.9057 (3.572)	
DEREG	.0463 (2.664)			
TIME		.0057 (1.881)		.0766 (3.955)
ONEPLUS	.0535 (2.693)		.1248 (4.328)	
ELECT	-.2208 (-.942)		-.1092 (-1.738)	
IXC	.0783 (2.490)	.1546 (3.001)		.1007 (2.466)
ln*ACCESS*	.2475 (6.368)		.3430 (6.840)	
STATE DUMMY VARIABLES	YES		YES	
F-statistic	49.23		60.52	
R-Squared	.9161		.9402	
Adj. R-Squared	.8970		.9546	
Instruments:	ln*INCOME* ln*UNEMPLOY*		ln*INCOME* ln*UNEMPLOY*	

having the same impact across groups. Given the endogenous right-hand side variable IXC_{st}, I use two-stage least squares regression to estimate the supply relation equations.

The coefficients of primary interest are on the dummy variables *DEREG* and *TIME*. The estimated coefficient on *DEREG* indicates an increase in the market conduct parameter following deregulation, resulting in a 4.6 percent increase in the market price. For the control and treatment groups the estimated coefficient on *TIME* indicates that the inter-period change in market conduct was responsible for a 0.57 and 7.7 percent increase in the market price, respectively.

To uncover an estimate of θ_1, α_1, and $(\theta_1^T+\alpha_1)$ it is necessary to divide the coefficients on *DEREG* and *TIME* by the estimated coefficients on *lnQ* as listed in Table 15. Standard errors and t-statistics are derived by employing the Delta method. For the full sample of 36 states $\overline{\theta}_1$ = 0.034 (s.e.=0.018), for the control sample $\overline{\alpha}_1$= 0.0048 (s.e.= 0.0034) , and for the treatment sample $\overline{\theta_1^T + \alpha_1}$= 0.050 (s.e.= 0.026).

The "difference-in-difference" estimator is employed to uncover an estimate of $\overline{\theta}_1^T$ as follows:

$$\overline{\theta_1^T + \alpha_1} - \overline{\alpha}_1 = .0501 - .00476$$

$$\overline{\theta}_1^T = .0453$$

The standard error of $\overline{\theta}_1^T$ is 0.021. Therefore, the estimated change in market conduct attributed to deregulation ($\overline{\theta}_1^T$ =0.045) is responsible for a (.045x1.528) 6.92 percent increase in the market price (s.e.=.0301). See Table 17 for a summary of the estimated market conduct results.

Table 17
Summary of Results
(t-statistics in parentheses)

	The General Model *Full Sample* (S=36, T=6) $\Delta\theta$	$\Rightarrow$ ΔP_{st}	The Regulatory Experiment Model *Treatment Group* (S=11, T=4) $\Delta\theta^T$	$\Rightarrow$ ΔP_{st}
Intrastate Deregulation (θ_1)	3.43 % (1.905)	4.63 % (2.664)	4.53 % (2.191)	6.92 % (2.296)
Unobserved Effects (α_1)			0.48 (1.511)	0.73 (1.201)
Equal Access IntraLATA Toll Comp. (θ_2)	3.98 (1.913)	5.35 (2.693)	8.17 (1.965)	12.48 (4.328)
Elected State Public Service Commissioners (θ_3)	-16.38 (.8912)	-22.08 (-.942)	-7.15 (1.465)	-10.92 (-1.738)
Facility-Based Interexchange Carriers (θ_4)	5.81 (1.824)	7.83 (1.490)	6.59 (1.647)	14.07 (2.466)

Both the results from the general model, employing the full sample of 36 states, and the results from the regulatory experiment model, employing the pooled control and treatment samples, support the hypothesis that regulation restricted the market conduct of the long-distance carriers. However, notice that one interpretation of this result is that regulators in price-cap states set price ceilings below the average costs of production. Therefore, the estimated increase in the market conduct parameter, which in turn caused an increase in the market price, instead reflects the convergence of the market price to a sustainable level and not the exercise of market power. Fortunately, the behavior of the market price under price-cap regulation makes this interpretation highly unlikely. M&R indicate that in more than half of the 9 states that imposed price ceilings in 1986, AT&T's rates were significantly below the ceiling. In addition, Ward's (1995) study of the interstate market in the 1990s found that price ceilings were binding on AT&T's rates for less than one-third of the price-cap period and Ward argues that even this measure may be overstated. Since the cap was more often binding after large changes due to significant decreases in the regulated carrier access prices, this one-third may reflect regulatory delay in reviewing AT&T rate changes.

The estimated impact of the political environment and market entry variables provide some interesting results. In both regressions the estimated coefficient on *EA* was positive and significant. As presented in Table 6, when a state introduced equal access competition in the *intraLATA* toll market this produced a 5.4 percent increase in the market price for the general model and 12.5 percent increase for the regulatory experiment model. This suggests that competition between the long-distance carriers diminished when entry to the intraLATA toll market was liberalized. It is important to recognize that this result holds regardless of the regulatory policy in the interLATA market, suggesting that implicit constraints on the carrier's rate setting behavior remain even after explicit rate regulation is eliminated. Therefore, changes in regulatory policy, whether applicable to the long-distance market or an external market, provide information to the long-distance carriers on the commitment of regulators to a deregulated market outcome. Accordingly, entry deregulation to the intraLATA toll market signals a pro-market attitude, which reduces the carriers' perceived probability of regulatory reintervention and, in turn, enables them to exploit more effectively their market power.

The coefficient estimate on *ELECT* provides some support for the hypothesized effect. In the pooled control and treatment regression, electing a public service commissioner had a statistically significant effect on conduct of -10.92 percent (t-stat=-1.738), whereas in the full sample regression the point estimate is -22.08 percent but is not statistically significant (t-stat=-0.942). The expected negative impact is based on a rent-seeking theory of regulation, that is, when a regulator's job is more closely linked to serving consumer interests, she will take more effort to restrict the conduct of the firms participating in the market.

The estimated coefficient on *IXC* is positive and significant in both regressions, indicating that the market price is higher in states where there are more facility-based carriers; or an increases in the number of carriers over time has a positive impact on market conduct, which in turn causes an increase in the market price. This result corroborates those found in Kaestner and Kahn (1990) and MacAvoy (1995). Therefore, it appears that the market entry into the intrastate long-distance markets played the opposite role that regulators had anticipated; that is, it failed to nurture the incentives of the carriers to engage in competition.

Finally, the estimated coefficient on *lnACCESS* is positive and significant in both models. In the general model *lnACCESS* is 0.248 and in the regulatory experiment model it is 0.343. These estimates suggest a positive relationship between fluctuations in access fees and the market price. It should be noted that, excluding a slight increase in a few states in 1992, access fees experienced significant declines throughout the sample period. The small magnitude of these estimated coefficients suggest that the carriers failed to pass through to consumers a significant portion of the cost savings they received from the declining price of this input.

3.6 Conclusion

The results indicate that, on average, the market conduct parameter increased as a result of deregulation; and in turn this caused an increase in the market price. These findings support the hypothesis that regulation restricted the market power of the long-distance carriers.

In the first of the two procedures this paper examines, a general model of market conduct was estimated employing the entire panel data set. A linear approximation of market conduct was specified as a function of regulatory, political, and structural variables. The empirical evidence supported the fundamental premise of this paper, which is that rate deregulation altered market conduct. It was determined that the market conduct parameter increased 3.43 percent following rate deregulation, which in turn caused a 4.63 percent increase in the market price.

The second procedure investigated the appropriateness of the conduct parameter's specification. This required disaggregating the panel data into control and treatment groups and examining the inter-period change in market conduct and unobserved factors. The estimated inter-period change in the treatment group's unobserved factors provided evidence that the specification of market conduct was appropriate. In particular, unobserved factors were responsible for a very small increase in the market conduct parameter of 0.48 percent, which caused a 0.73 percent increase in the market price. After netting out the impact of the unobserved factors, the impact of rate deregulation on the treatment group caused a 4.52 percent increase in the group's market conduct parameter, which in turn caused a 7.66 percent increase in the market price.

Additional evidence that suggested non-competitive behavior was found on the coefficients for *EA* and *IXC*. In both the general and regulatory experiment models when a state deregulated entry to the intraLATA toll market this had a positive impact on market conduct in the interLATA market. This result suggests that state regulators influenced market conduct in both regulated *and* deregulated markets. While deregulation removed explicit constraints on price-setting conduct, implicit constraints remained in the form of the regulator's attitude or commitment to promoting a market outcome. That is, entry deregulation to the intraLATA toll market signaled a deregulatory attitude, which reduced the probability of regulatory interference and thus enabled the long-distance carriers to more effectively exercise their market power.

The positive and significant coefficient estimates on *IXC* determined that markets with a larger number of facility-based carriers produced higher prices. While this is an unexpected (and undesirable) empirical relationship it corroborates the finding of

Kaestner and Kahn (1989) and MacAvoy (1995). Regardless of its interpretation it is not consistent with competitive behavior and instead suggests that collusion may be the underlying cause.

The model in this paper extends earlier models that examined the impact of regulatory change on long-distance prices by explicitly considering the influence of market conduct. While such an exercise cannot be interpreted as a complete analysis of market power, it does uncover several results that conflict with what one would observe under competition and lends empirical support to the premise that the long-distance carriers have significant control over the market price.

Appendix 3A

Regulation of Intrastate InterLATA Rates — 1991 to 1996

STATE*	YEAR	RATE REGULATORY POLICY**
1) Alabama	1991-94	Price floor.
	1995-96	Price floor, plus mandatory pass through of all changes in access fees.
2) Arizona	1991-96	Price cap and floor.
3) Arkansas	1991-95	Flexible pricing: PSC approval of all price changes, with a required 30 day notice period.
	1996	Deregulated.
4) California	1991-92	Rate of return.
	1993-96	Flexible pricing: PSC approval of all price changes.
5) Colorado	1991-96	Price cap and floor.
6) Florida	1991-92	Price cap and floor, plus mandatory pass through of all changes in access fees.
	1993-96	Flexible pricing, with no mandatory pass through of changes in access fees.
7) Georgia	1991-96	Regulatory policy not known by author.
8) Idaho	1991-96	Deregulated.
9) Illinois	1991-96	Price floor.
10) Indiana	1991	Price floor, plus mandatory pass through of all changes in access fees.
	1992-96	Deregulated.
11) Iowa	1991-96	Deregulated.
12) Kansas	1991-92	Banded rate of return.
	1993-96	Streamlined regulation. No cost of service studies required.

13) Kentucky	1991-93	Rate of return.
	1994-96	Streamlined regulation. Limited PSC review of prices.
14) Louisiana	1991-94	Banded rate of return.
	1995-96	Streamlined regulation.
15) Maryland	1991-93	Banded rate of return.
	1994-96	Price cap.
16) Massachusetts	1991-92	Rate of return.
	1993-96	Price cap.
17) Michigan	1991	Price cap.
	1992-96	Deregulated.
18) Minnesota	1991-93	Price floor.
	1994-96	Deregulated.
19) Mississippi	1991	Banded rate of return.
	1992-96	Price cap and floor.
20) Missouri	1991-92	Price cap and floor.
	1993-96	Deregulated.
21) Montana	1991-94	Price cap, plus mandatory pass through of all changes in access fees.
	1995-96	3 year deregulation "experiment."
22) Nebraska	1991-96	Deregulated.
23) Nevada	1991-94	Price cap and floor.
	1995-96	Deregulated.
24) New Jersey	1991	Banded rate of return.
	1992-96	Deregulated.
25) New York	1991-96	Price cap.
26) North Carolina	1991-96	Price cap.
27) North Dakota	1991-96	Deregulated.

28) Ohio	1991-93 1994-96	Price cap and floor. Deregulated.
29) Oklahoma	1991-96	Streamlined regulation. Limited PSC review of prices.
30) Oregon	1991-96	Deregulated.
31) Pennsylvania	1991-93 1994-96	Price cap and floor. Deregulation.
32) South Carolina	1991-96	Price cap.
33) Tennessee	1991-96	Price cap.
34) Texas	1991-92 1993-96	Price cap and floor. Deregulated.
35) Virginia	1991-96	Deregulated.
36) Washington	1991-96	Streamlined Regulation. Limited PSC review of prices.
37) West Virginia	1991-96	Regulatory policy not known by author.
38) Wisconsin	1991 1992-94 1995-96	Price cap. Flexible pricing with a revenue cap. Deregulation.

*__The following 12 states are single-LATA states__:

1) Alaska
2) Connecticut
3) Delaware
4) Hawaii
5) Maine
6) New Hampshire
7) New Mexico
8) Rhode Island
9) South Dakota
10) Utah
11) Vermont
12) Wyoming

**__Sources__

The National Association of Regulatory Utility Commissioners(NARUC), *Utility Regulatory Policy in the United States and Canada*, Table 100 (1991-96).

Corroboration of the NARUC report, plus additional detail on rate regulation, was acquired from the above state's Public Service Commission staff members.

Appendix 3B

Non-linear Regression Results

Table 18
Non-linear Least Squares Estimates: Supply Relation
Dependent Variable: $\ln P_t$
(t-statistics in parentheses)

	The General Model *Full Sample* (S=36, T=6)	The Regulatory Experiment Model *Control Group** (S=11, T=4)	The Regulatory Experiment Model (pooled)	The Regulatory Experiment Model *Treatment Group*** (S=11, T=4)
INTERCEPT	0.529 (3.688)		0.945 (11.928)	
DEREG	0.044 (4.530)			
TIME		0.004 (1.116)		0.102 (2.586)
EA	0.055 (1.989)		0.091 (7.761)	
ELECT	-0.127 (-1.652)		-0.075 (-2.139)	
IXC	0.111 (2.309)	0.156 (5.506)		0.067 (3.170)
ln*ACCESS*	0.275 (4.505)		0.409 (5.645)	
STATE DUMMY VARIABLES	YES		YES	
F-statistic	362.18		107.88	
R-Squared	0.9238		0.9620	
Adj. R-Squared	0.9213		0.9530	
Instruments:	ln*INCOME* ln*UNEMPLOY*		ln*INCOME* ln*UNEMPLOY*	

Chapter Four

An Empirical Test for the Presence of Political Slack and Strategic Firm Behavior in the Transition to Rate Deregulation in the Intrastate Long-Distance Telecommunications Markets

The greatness of mind which manifests itself in conspicuous leadership in marshaling human and material forces is wanted for the regulation of public utilities...Nothing is more effective in obtaining the needed qualifications than an active and sustained public interest in regulation.
-Kerr, W.D. "Qualifications Needed for Public Utility Commissioners." *The Annals of the American Academy*, Vol.53 (1914), p.27

The typical undergraduate textbook on public utilities treats regulatory commissions as bodies of automatons, selflessly devoting themselves to an effort to implement *Smyth v. Ames*[1]...Economists have come to realize that this is not an accurate description of the regulatory process. Regulators are not automatons, but men and women who go to baseball games, advocate their political philosophies, have their gallbladders removed, take their cats to the veterinarian, and otherwise behave like the rest of us.
-Hilton, G. "The Basic Behavior of Regulatory Commissions." *American Economic Review*, May 1972, p.47.

4.1 Introduction

While rate deregulation today predominates in the intrastate long-distance telecommunications markets, its achievement was gradual. During the five years following the AT&T divestiture (1984-88) 28 of the 38 multi-LATA states[2] eliminated traditional rate-of-return (ROR) regulation, with 21 states choosing pricing-flexibility (PF) regulation (i.e., price-cap regulation, banded ROR regulation, moratorium regulation, etc.)[3] and just seven states choosing rate deregulation.[4] In contrast, between

[1] 169 U.S. 466 (1898).
[2] LATA, short for Local Access and Transport Area, is a geographic entity created at the time of divestiture as the demarcation boundary for the Regional Bell Operating Companies (RBOCs). Calls which cross the LATA boundary are referred to as interLATA calls and must be passed off to a long-distance carrier. Intrastate interLATA calls are under the regulatory jurisdiction of state Public Service Commissions (PSCs). Interstate InterLATA calls are regulated at the federal level by the Federal Communications Commission (FCC).
[3] See Kridel, Sappington, and Weisman (1996), pp. 271-274, for a detailed description of PF regulatory policies.

1989-96 the pool of rate deregulated states increased from seven to 25, PF regulated states decreased from 21 to 13, and traditional ROR regulated states decreased from 10 to zero.[5]

Because the process evolved gradually, post-divestiture deregulation in the intrastate long-distance markets provides an excellent laboratory to investigate Public Service Commissions' (PSC) decisions to implement regulatory change.[6] Several recent papers have examined the matter with regards to the initial transition from ROR to PF regulation.[7] However, no research (to the author's knowledge) has been conducted on the more recent transition from PF regulation to rate deregulation. Given the difference in these two periods, it is of interest to ascertain the economic and political factors that explain the transition to rate deregulation.

In particular, there are two distinctions between ROR and PF regulatory environments that could produce variation in the decision to implement regulatory change. First, the pricing flexibility that the firm is endowed with under PF regulation provides it with a strategic instrument to influence the future course of regulation. The product of this strategic behavior is referred to as a "demonstration effect."[8] Specifically,

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[4] Between 1984-88 the following 21 states switched to a PF regulatory policy: AL, AZ, FL, GA, KS, LA, MD, MI, MS, MO, MT, NV, NJ, NY, NC, OH, PA, SC, TN, TX, WV. The following seven states were rate deregulated between 1984-88: ID, IL, MN, NE, OK, VA, WA.

[5] The 13 PF regulated states as of year-end 1996 were AL, AZ, CO, GA, MA, MD, MS, MT, NC, NY, SC, TN and WV.

[6] With only a single exception, the decision to deregulate intrastate long-distance services has been left to the state public service commissions. Nebraska, being the exception, was deregulated by state statute (Legislative Bill 835) on January 1, 1987. Fortunately, for unrelated reasons, explained in section 4.4, Nebraska is excluded from the sample.

[7] Teske (1991) and Donald and Sappington (1995) examine regulatory choice in the intrastate local telephone service markets, while Kaserman, Mayo and Pacey (1993) examine regulatory choice in the intrastate long-distance markets.

[8] For a specific discussion of the demonstration effect see Sappington and Weisman (1996). For a general discussion of the strategic use of the political process see Ordover and Soloner (1989), pp.570-579.

the regulated firm's price affects the welfare of multiple interest groups with a stake in the regulatory process. In turn, an increase or decrease in the regulated price alters the equilibrium political support a regulator derives from these groups (i.e., constituent votes, campaign contributions, future employment, etc.).[9] Recognizing this relationship, namely that a regulator's indirect utility is a function of the regulated price, the firm can influence the regulatory process by adjusting this variable to increase the support for (or diminish the opposition to) its preferred outcome. Notice that ROR regulation does not impose absolute constraints on the regulated price. Thus, in theory, a demonstration effect can be observed in a ROR environment. However, the likelihood of such an outcome is diminished by the relatively narrow pricing flexibility permitted under ROR.

Second, the interim status of PF regulation contributes to the demonstration effect in that one is more likely observe a divergence from the static (per period) profit maximizing equilibrium in an environment receptive to regulatory change. Therefore, research on the transition from PF regulation to rate deregulation presents an issue distinct from the previous research on the transition from ROR to PF regulation: The regulated price and regulatory policy must be treated as endogenous variables in a model of the regulatory process.

The objective of this paper is twofold. First, I test for the presence of a demonstration effect in the transition from PF regulation to rate deregulation in the intrastate long-distance markets. In doing so, I specify a simultaneous equations (Logit-OLS) model based on a private interest theory of economic regulation. The logit equation is based on a binary dependent variable [*DEREG*] that distinguishes between

[9] See Joskow (1974) for a discussion on the influence of the regulated price on regulator behavior.

rate deregulated (1) and PF regulated (0) states. The equation is specified as a function of the regulated firm's price [*PRICE*]. The OLS equation examines the causal effect of *DEREG* on *PRICE*. Therefore, a two-stage/instrumental variables procedure is implemented to eliminate the inconsistency of the coefficients attributed to the endogeneity of the regulated price and regulatory choice. Assuming the regulated firm seeks rate deregulation, a necessary condition to support a demonstration effect is that the coefficient sign on *DEREG* in the OLS equation correspond with the coefficient sign on *PRICE* in the logit equation. For example, if it is determined from the logit equation that a decline in *PRICE* increases the probability of rate deregulation, then to derive a strategic interpretation a negative correlation must exist between *PRICE* and regulatory policy in the OLS equation.

A consensus exists in the literature that a regulator's private interests are integral to predicting regulatory change.[10] An open issue, however, is the degree to which regulators operate with political slack, as suggested by Kalt and Zupan (1984). Therefore, a second objective of the paper is to test the Kalt and Zupan theory against the alternative hypothesis of a private interest theory of regulation without political slack, as suggested by Stigler (1971) and Peltzman (1976). The test proceeds by including a variable in the logit equation that controls for the product of slack, namely regulator "shirking," and it then examines the model's response to the inclusion of this variable. A key insight is the prediction that a decrease in slack increases the price of shirking. Thus, as the price of shirking rises we will observe a decline in its consumption.

[10] See Noll (1989) for a survey of the literature.

The next section contains a brief review of the literature. Following this, in section 4.3 I sketch a simple theoretical model that I then test. Section 4.4 describes the estimation procedure. Section 4.5 presents the results and section 4.6 concludes. Before proceeding I briefly summarize my findings.

Two variables were included to control for the strength of an interest group's presence in a state. First, a positive correlation was found between the intensity of business consumer interests, measured as the ratio of business to total local access lines, and the probability of rate deregulation. Business customers typically favor rate deregulation; thus, this positive relationship indicates their interests played a role in the regulatory process. Second, the intensity of rural interests were examined by controlling for the percentage of a state's non-urban population. The coefficient estimate on this variable failed to achieve economic or statistical significance. This result suggests that rural consumers (*i*) do not fear their subsidized services are threatened by rate deregulation and/or (*ii*) their greater presence in a state failed to produce a corresponding increase in organized political opposition to rate deregulation.

The variable *PRICE* was included to test for the presence of a demonstration effect as well as examine the influence of a group's stake in promoting or opposing rate deregulation. First, the negative coefficient estimates on *PRICE* and *DEREG* in the logit and OLS equations, respectively, failed to reject a demonstration effect hypothesis. Second, the negative coefficient on *PRICE* in the logit equation suggests that on average a decline in *PRICE* produced an increase in business consumer and (possibly) regulated firm support for rate deregulation that dominated the opposition to rate deregulation by residential consumers.

Prior employment characteristics of the commissioners were examined by including two variables measuring the percentage of commissioners previously employed as (residential) consumer advocates or senior level business managers/owners. The hypothesis is that the variables proxy for regulator bias, namely, the tendency to promote the interests of constituent groups with which he or she has had prior affiliation. In turn, I argue this bias reduces the interest group's costs in promoting support for its desired outcome. The negative and positive coefficient estimates on the respective variables supported this hypothesis. Unfortunately, it is uncertain whether the underlying motivation for this behavior is ideological shirking or the product of constituent influence. Thus, the variables' inclusion in the model was for control purposes and were not be utilized to test for the presence of slack.

The presence of slack was confirmed by a separate variable. To conduct this test I initially included two variables to proxy for the price of shirking, defined as the percentage of *elected* and *appointed* commissioners in the final year of their terms in office. The variables controlled for a specific type of shirking, namely, a regulator's proclivity for leisure or maintaining the status quo. Two hypothesis were tested: The first hypothesis asserts that political support of constituents is of greater value to the regulator in the year he or she is running for reelection or reappointment. Consequently, the price of shirking in this year will increase and result in a corresponding increase in the probability of rate deregulation. This outcome is the product of three reinforcing effects: an increase in the price of shirking generates (*i*) a decline in the regulator's consumption of status quo shirking , which causes (*ii*) an increase in the political support and (*iii*) a decline in the political opposition to rate deregulation. The second hypothesis states that variation exists in the slack of elected and appointed commissioners. The results rejected the latter hypothesis but failed to reject the former. Thus, for efficiency purposes I pooled the variables. The pooled results supporting the first hypothesis are reflected in a sizable increase in the model's goodness of fit upon inclusion of the variable: the pseudo-R^2, increased to 0.727 from 0.601, and a positive, statistically significant coefficient estimate.

4.2 Literature Review

This section is divided into two parts: Part A reviews the theoretical literature on economic regulation, while part B describes the empirical literature on regulatory change as applied to the telecommunications industry.

A. The Theory of Economic Regulation

For much of this century the prevailing theory of economic regulation has been the Public Interest (PI) theory.[11] The standard assumption of PI theory is that regulators are fully informed agents of the public interest. Given this premise, the regulatory objective is to maximize total social surplus subject to the constraints of market demand and supply. Clearly, a weakness in PI (as a positive) theory derives from the assumption that regulators are fully informed and publicly motivated. In fact, the theory has been often criticized as a product of "normative wishings, rather than an explanation of real world phenomena."[12]

[11] See Posner (1974) for a description of the evolution of PI theory in the economics literature.
[12] See Kalt and Zupan (1984), p.279.

The publication of Stigler's *Theory of Economic Regulation* in 1971 "crystallize[d] a revisionism in the economic analysis of regulation."[13] The Stiglerian theory of regulation is based on the premise that regulators are political agents, not (necessarily) concerned with the public interest. Instead, regulation is a political process "which contending interests seek to leverage in their pursuit of wealth."[14] Five years later Peltzman (1976) generalized the Stiglerian theory, which in the interim had assumed the humble title "the Economic Theory of Regulation."[15] Peltzman's contribution was the introduction of an explicit model of the political regulatory process whereby the regulator's objective function entailed maximization of "political support" (i.e., votes, campaign contributions, future employment, etc.). From this model Peltzman derived the result that interest groups drive the political process; success in achieving regulatory "capture" (or influence) is predicated on a group's inherent advantage of larger stakes and resources, smaller size, or greater jurisdictional mobility.

Following Kalt and Zupan (1984) a reformulation of the Stigler-Peltzman theory ensued.[16] The authors indicate "that approaches which confine themselves to a view of political actors as narrowly egocentric maximizers explain and predict legislative [or more generally, political] outcomes poorly."[17] The authors highlight shortcomings of the principal-agent relationship in the institution of politics: Slack in a constituent's control of his or her political representative - produced by policing costs, opportunism, and

[13] See Peltzman (1976), p.211.
[14] See Peltzman (1976), p.212.
[15] This title, introduced by Posner (1974), is in recognition of Stigler's (1971) seminal contribution.
[16] The post-Kalt and Zupan (1984) literature on political "shirking" is huge. A sample of some notable contributions include Levitt (1996), Poole and Romer (1993), Lott and Davis (1992), Bender (1991), Levine and Forrence (1990), McCubbins, Noll and Weingast (1990), Davis and Porter (1989), Dougan and Munger (1989), McArthur and Marks (1988), and Nelson and Silberberg (1987).

appropriability - provides the representative with an opportunity to shirk, that is, seek maximization of an objective function that includes non-political support variables. The authors demonstrate that principal-agent slack plays a significant role in explaining political behavior and, thus, conclude that a politician's (slack induced) shirking behavior should be incorporated into positive models of politics.

B. Empirical Analysis of Regulatory Change: the Telecommunications Industry

Much attention has been devoted to theoretical investigations of the merits and shortcomings of ROR and PF regulation.[18] In addition, significant empirical work has examined the effects of regulatory policy on the performance of the telecommunications industry.[19] However, there are relatively few empirical analyses of the reasons why regulatory change is adopted in telecommunications markets.

Three recent papers - Kaserman, Mayo and Pacey (1993), Teske (1991) and Donald and Sappington (1995) - investigate the transition from ROR to PF regulation;[20] the first examines the intrastate long-distance markets and the latter two, local telephone service markets. They differ from the present study, however, in two fundamental respects. First, the influence of the regulated firm's strategic price-setting behavior, that is the demonstration effect, is not examined. This is not surprising given the authors

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[17] See Kalt and Zupan (1984), p.279.

[18] See, for example, Averch and Johnson (1962), Baumol and Klevorick (1970), Joskow and Schmalensee (1986), Symposium on Price-Cap Regulation in *Rand Journal of Economics* (1989), Pint (1992), Liston (1993), and Sappington (1994).

[19] See, for example, Mathios and Rogers (1989), Kaestner and Kahn (1990, 1991), Hubor, Kellogg, and Thorne (1992), Hall (1993), Taylor and Taylor (1993), Ward (1995), MacAvoy (1995, 1996), Kahai, Kaserman and Mayo (1996), Taylor and Zona (1997), and Knittel (1997).

examine regulatory transition in a ROR environment. The probability of observing a demonstration effect under ROR regulation is diminished by the relatively strict constraints imposed on the regulated firm's price. Thus, a study of regulatory transition in a PF environment offers a unique opportunity to investigate an issue that has yet to be addressed in the literature.

Second, the empirical models used in these earlier studies are based on public interest and private interest "political support" theories of economic regulation. In particular, they do not consider the influence of slack on regulator conduct. This is an interesting omission given the controversy that has ensued since the publication of Kalt and Zupan (1984). The post-Kalt and Zupan literature on political slack is substantial. While a consensus has yet to be reached on the role of slack in the regulatory process, a disregard for the issue deserves an explanation which the authors do not provide.

The previous studies, of course, do have an important feature in common with the present research, namely, they all examine the same intrastate regulatory institutions (e.g., state Public Service Commissions). Thus, while their results may not be entirely relevant here, they do offer guidance on constructing an empirical model and provide insight to economic and political factors that influence the regulatory process.

[20] Application to the electricity industry is found in Nowell and Tschirhart (1990) whom examine the factors influencing state regulators' compliance with the federal Public Utility Regulatory Policies Act of 1978. Oster (1980) examines some of the causes for interstate differences in social regulation.

4.3 A Model of Regulatory Transition

In this section I present a simple model that informs the empirical analysis that follows. I begin by describing the model in section A, and then derive the empirical predictions of the model in section B.

A. Description of the Model

The model presented in this section is based on Peltzman (1974) and Donald and Sappington (1995). I analyze a setting with two possible regulatory regimes: PF regulation and rate deregulation. The regulator is specified as a private interest, utility maximizing agent, where the likelihood he or she chooses rate deregulation depends on the level of utility under rate deregulation relative to the level of utility under PF regulation.[21] Let $U(DEREG = 1)$ denote the former and $U(DEREG = 0)$ denote the latter. The probability of rate deregulation is given by

$$\begin{aligned} P(DEREG = 1) &= P[U(DEREG = 1) > U(DEREG = 0)] \\ &= P[U(DEREG = 1) - U(DEREG = 0) > 0] \end{aligned} \tag{4.1}$$

Because a regulator's utility is unobserved by the econometrician, I rely on the Stigler-Peltzman "political support" theory of economic regulation and the modification to this theory suggested by Kalt and Zupan as guides in specifying the variables likely to influence the level of regulator utility associated with rate deregulation. Thus, I get the following:

[21] Following McFadden (1974, pp.105-142), I employ a logit model to analyze the regulator's decision to implement rate deregulation. See Section 4.4 for a description of the econometric model.

$$\begin{aligned} \Delta Utility &= U(DEREG=1) - U(DEREG=0) \\ &= n^S SUP - n^O OPP - U_{PF}(R_{SH}) \end{aligned} \quad (4.2)$$

Equation (4.2) states that the regulator's decision to implement rate deregulation is predicated on (*i*) the support for rate deregulation exerted by group *S*: $n^S SUP$, where n^S is the size of group *S* and *SUP* is the (net) probability that a beneficiary of rate deregulation grants support, (*ii*) the opposition to rate deregulation exerted by group *O*: $n^O OPP$, where n^O is the size of group *O* and *OPP* is the (net) probability that those harmed by rate deregulation oppose, and (*iii*) the status quo utility a regulator derives from maintaining PF regulation: $U_{PF}(R_{SH})$, where R_{SH} is the price, or opportunity cost, from engaging in status quo shirking activity.

Notice that a regulator's non-political support, or "shirking," behavior derives from his or her unobserved personal values and motivations. Also, the impact of shirking on the regulatory process is complex and often difficult to predict. To simplify the analysis, $U_{PF}(R_{SH})$ controls for a specific type of regulator conduct produced by slack. The model examines shirking produced by variation in the regulators' motivations to act on an issue. In general, maintaining the status quo regulatory policy enables the regulator to avoid the effort necessary in becoming informed of the alternative policy and supervising its implementation. It may also be the case that a regulator's inaction poses fewer risks to his or her future than the alternative. Therefore, the price of status quo shirking reflects the net foregone political support incurred by the regulator in maintaining PF regulation. Accordingly, an increase in R_{SH} diminishes the utility derived from the consumption of status quo shirking: $\partial U_{PF}/\partial R_{SH} < 0$.

I specify two interest groups as the principal sources of political influence: The (group *S*) political support for rate deregulation is produced by business consumers and the (group *O*) political opposition to rate deregulation is generated by residential consumers. While the producers of long-distance service clearly have a stake in the regulatory process, the position of these parties and their relative political strength does not vary substantially across states. As a result, I do not directly control for producer interests. Instead, per the demonstration effect, AT&T's is assigned an indirect role whereby the carrier's interests are reflected in its strategic manipulation of the regulated price.[22]

The probability of group *S* support is defined as a function of x: $SUP = SUP(x)$, where x is the per capita net benefit to group *S* from eliminating PF regulation and is specified

$$x = \frac{\left|\Delta W^{S}(PRICE)\right| - CPS^{S}\left(Y^{S}, R_{SH}\right) - CO^{S}\left(n^{S}\right)}{n^{S}} \tag{4.3}$$

The probability of group *O* opposition is defined as a function of y: $OPP = OPP(y)$, where y is the per capita net benefit to group *O* from retaining PF regulation and is specified

[22] A variable measuring the number of non-regulated facility-based carriers was initially included in the model (which I describe in section 4.4). The coefficient on the variable did not achieve economic or statistical significance. Two shortcomings of the variable may explain this result. First, as mentioned, there is little variation in relative strength of carrier participation across states. In fact, the two carriers that comprise the majority share of non-regulated carriers, MCI and Sprint, experienced no change in their market participation during the sample period. Second, the variable may not accurately control for the carriers' relative stakes. Clearly, a measure of market share is preferred. Unfortunately, such data is not publicly available. Therefore, the inaccuracy of the coefficient estimate may derive from a weak correlation between a carriers' stakes and market participation.

$$y = \frac{\left|\Delta W^{O}(PRICE)\right| - CPS^{O}\left(Y^{0}, R_{SH}\right) - CO^{O}\left(n^{O}\right)}{n^{O}} \quad (4.4)$$

I assume that the per capita benefits to group S from eliminating PF regulation and the per capita benefits to group O from retaining PF regulation are positively correlated with the groups' respective probabilities of support and opposition: $SUP_x > 0$ and $OPP_y > 0$. The variables in equations (4.3) and (4.4) are defined as follows:

$|\Delta W^i(\bullet)|$ = Absolute value of the Change in group i's welfare when rate deregulation replaces PF regulation, where $\partial x / \partial \left|\Delta W^{S}\right| > 0$ and $\partial y / \partial \left|\Delta W^{O}\right| > 0$;

$CPS^i(\bullet)$ = Costs incurred by group i to promote support for (or mitigate opposition to) its preferred outcome, where $\partial x / \partial CPS^{S} < 0$ and $\partial y / \partial CPS^{O} < 0$;

$CO^i(n^i)$ = Organizational costs incurred by group i to inform members of their stakes and motivate activity in support of the group's preferred outcome, where $\partial x / \partial CO^{S} < 0$, $\partial y / \partial CO^{O} < 0$ and $\partial CO^{i} / \partial n^{i} > 0$;

Y^i = Group i specific cost shift variables;

R_{SH} = Price to the regulator of engaging in non-political support "shirking" activity; and

$PRICE$ = PF regulated price of *residential* long-distance telephone service.

I now briefly comment on the underlying assumptions of equations (4.3) and (4.4). First, the specification of $PRICE$ as a determinant of $|\Delta W^S(\bullet)|$ and $|\Delta W^O(\bullet)|$ derives from information asymmetry and cross-subsidization of telecommunications services.[23] Namely, business consumers are the primary source of revenues used to subsidize other consumer groups, while residential consumers are the primary recipients of these revenues. Consequently, the former has sought to eliminate cross-subsidization

[23] Cross-subsidization has a long and complicated history in the telecommunications industry. Numerous books and journal articles discuss its evolution. Notable contributions include Horwitz (1989), Temin (1990), Brock (1994) and MacAvoy (1996).

by supporting the relaxation of regulatory controls and the latter, attempting to maintain its subsidized services, has typically opposed such measures. Given the plethora of information necessary to evaluate the true extent of the cross-subsidy, I assert that consumers rely on a rule-of-thumb calculation to estimate the change in their welfare: (residential) *PRICE* acts as an indicator of the extent of cross-subsidization. In turn, if rate deregulation succeeds in reducing or eliminating cross-subsidies, *PRICE* proxies for the extent of welfare gain to *S* and loss to *O* expected from rate deregulation. Thus, a decline in *PRICE* suggests an increase in $|\Delta W^i|$, i.e., $\partial|\Delta W^i|/\partial PRICE < 0$. While the relationship is specified as having a symmetric impact on group *S* and *O*, the magnitude of this impact is allowed to vary across the two groups.

Notice that a demonstration effect also is dependent on information asymmetry and is operationalized by the regulated firm's manipulation of $|\Delta W^i(PRICE)|$. In particular, the regulated carrier is assumed to have complete information on its costs and, thus, is cognizant of the true cross-subsidy between business and residential consumers. Given this informational advantage, the regulated firm can adjust *PRICE* (within the confines of the PF constraints) to exploit the trade-off between group *S* support and group O opposition. For example, in an attempt to generate $\Delta Utility > 0$, the firm could initiate a price decrease that produced an increase in equilibrium group *S* support of greater magnitude than that of group *O* opposition.

Second, the <u>net</u> impact of group size on the benefits to retaining ($\partial y/\partial n^O$) or eliminating PF regulation ($\partial x/\partial n^S$) is ex-ante indeterminate. An increase in n^i provides a broader base of support which necessarily reduces the per capita costs of promoting support for group i's interests $[CPS^i(\bullet)/n^i]$ and potentially reduces the per capita organization costs $[CO^i(n^i)/n^i]$. However, an increase in n^i necessarily dilutes group i's per capita stake in the regulatory outcome $[|\Delta W^i(\bullet)|/n^i]$ and increases the total organization costs $[CO^i(n^i)]$.

Third, Y^i and R_{SH}, the determinants of $CPS^i(\bullet)$, measure the effect of group i's expenditures to promote support for their preferred outcome. As a normalization, for any value of R_{SH}, higher values of $Y^i \in [0, 1]$ denote environments in which support expenditures are more effective; $\partial CPS^i/\partial Y^i < 0$. Finally, for any value of Y^i, the greater is a regulator's disregard for group S support, the less effective is group S's support expenditure; since the consumption of shirking is negatively correlated with its price this implies $\partial CPS^S/\partial R_{SH} < 0$. Conversely, a greater regard for the status quo suggests an increase in the effect of group O's support expenditure; $\partial CPS^O/\partial R_{SH} > 0$.

The primary objective is to estimate the likelihood that a state chooses to adopt rate deregulation in place of PF regulation. Substituting equations (4.3) and (4.4) into equation (4.2) produces the following:

$$\begin{aligned}\Delta Utility = {} & n^S\, SUP\left[\frac{\left|\Delta W^S(PRICE)\right| - CPS^S\left(Y^S, R_{SH}\right) - CO^S\left(n^S\right)}{n^S}\right] - \\ & n^O\, OPP\left[\frac{\left|\Delta W^O(PRICE)\right| - CPS^O\left(Y^O, R_{SH}\right) - CO^O\left(n^O\right)}{n^O}\right] - U_{PF}(R_{SH})\end{aligned} \tag{4.5}$$

The foregoing model predicts that rate deregulation will prevail in regulatory settings where $\Delta Utility > 0$ is more likely to hold.

B. Testable Implications of the Model

I now identify the factors in the model that lead to an increase or a decrease in $\Delta Utility$.

Observation 1: $$\frac{d\Delta Utility}{dn^S} = SUP - \frac{\partial SUP}{\partial x}\left[\frac{\left|\Delta W^S\right| - CPS^S - CO^S}{n^S} + \frac{\partial CO^S}{\partial n^S}\right] \begin{matrix} > \\ = \\ < \end{matrix} 0 \text{; and}$$

$$\frac{d\Delta Utility}{dn^O} = -OPP + \frac{\partial OPP}{\partial y}\left[\frac{\left|\Delta W^O\right| - CPS^O - CO^O}{n^O} + \frac{\partial CO^O}{\partial n^O}\right] \begin{matrix} > \\ = \\ < \end{matrix} 0$$

The indeterminacy of a change in group size on regulator utility is attributed to the uncertainty of its impact on the group's net benefits to retaining/eliminating PF regulation. This is reflected in Observation 1 by the potentially conflicting impact of the first and second right-hand side components. While the sign of the first component is unambiguous (SUP, $OPP \geq 0$), the sign of the second component depends on the magnitude of the increase in support/opposition produced from a decline in CPS^i/n^i and CO^i/n^i, relative to the decline in support/opposition produced from a decline in $|\Delta W^i|/n^i$ and an increase in CO^i.

In the empirical analysis that follows, I examine the necessary condition that if group size improves a group's influence we will observe (*i*) a positive relationship between n^S and $\Delta Utility$ ($d\Delta Utility/dn^S > 0$), and (*ii*) a negative relationship between n^O and $\Delta Utility$ ($\Delta Utility/dn^O < 0$).

Observation 2: $$\frac{d\Delta Utility}{dY^S} = -\frac{\partial SUP}{\partial x}\frac{\partial CPS^S}{\partial Y^S} > 0 \text{; and}$$

$$\frac{d\Delta Utility}{dY^O} = \frac{\partial OPP}{\partial y}\frac{\partial CPS^O}{\partial Y^O} < 0$$

Observation 2 holds because an increase in the effect of costs incurred to mitigate (promote) support for rate deregulation, ceteris paribus, increases an interest group's net benefit to maintaining (eliminating) PF regulation. The product of larger benefits is greater political opposition to (support for) rate deregulation.

Observation 3: $$\frac{d\Delta Utility}{dR_{SH}} = -\frac{\partial SUP}{\partial x}\frac{\partial CPS^{S}}{\partial R_{SH}} + \frac{\partial OPP}{\partial y}\frac{\partial CPS^{O}}{\partial R_{SH}} - \frac{\partial U_{PF}}{\partial R_{SH}} > 0$$

Observation 3 states that an increase in R_{SH} necessarily increases the effect of support expenditures (CPS^{S}), while simultaneously diminishing the effect of opposition expenditures (CPS^{O}) and the utility derived from status quo shirking. The product of these three responses is a necessary increase in $\Delta Utility$.

Observation 4: $$\frac{d\Delta Utility}{dPRICE} = n^{S}\frac{\partial SUP}{\partial\left|\Delta W^{S}\right|}\frac{\partial\left|\Delta W^{S}\right|}{\partial PRICE} - n^{O}\frac{\partial OPP}{\partial\left|\Delta W^{O}\right|}\frac{\partial\left|\Delta W^{O}\right|}{\partial PRICE} \begin{matrix} > \\ = \\ < \end{matrix} 0$$

Observation 4 indicates the marginal change in group *S* support (1st component) and group *O* opposition (2nd component) produced by a change in *PRICE*. The indeterminacy of the sign on *d*Δ*Utility*/*dPRICE* is attributed to the unknown magnitude of the change in an interest group's welfare produced by a change in *PRICE*.

Another confounding factor is the regulated firm's manipulation of *PRICE*, i.e., the demonstration effect. Since the 1984 divestiture, the regulated carrier AT&T has voiced strong opposition to the rate regulation imposed on its services. Therefore, the hypothesis is that AT&T will utilize its pricing flexibility and information on the political support group *S* and opposition of group *O* to manipulate the regulatory process. By adjusting its price AT&T can rebalance the regulator's equilibrium political support to increase the probability of rate deregulation. Therefore, the effect of *PRICE* on Δ*Utility*, be it positive or negative, may indicate the influence of the regulated carrier's opposition to rate deregulation.[24]

While *dΔUtility/dPRICE* is ex-ante indeterminate, a negative correlation suggests business consumer and (possibly) regulated firm support for rate deregulation, but rejects regulatory capture by residential interest groups. However, a positive correlation indicates the influence of residential consumer opposition and (possibly) regulated carrier support for rate deregulation, but rejects regulatory capture by business consumers.

4.4 Empirical Analysis

The data consist of a panel of 83 observations between 1991-95 on 24 multi-LATA states. A state was selected for inclusion if subject to PF regulation by year-end 1990. 14 of the 24 states selected for inclusion approved a rate deregulatory policy between 1991-95.[25] Note that the independent variables used to predict the probability of rate deregulation are likely affected by the change in regulatory environment. To eliminate this endogeneity problem I include time-series observations on the 24 PF regulated states up to the year *preceding* the date rate deregulation was implemented;[26] post-deregulation observations on these states are eliminated from the data set. Therefore, the panel consists of observations on PF regulated states only; the number of

[24] In the following section I describe the two-stage econometric techniques necessary to control for the inconsistency attributed to the endogeneity of *PRICE*.

[25] Of the 24 multi-LATA states included in this study 14 approved rate deregulation between 1991-95 [AR, FL, IN, KS, LA, MI, MN, MO, NJ, NV, OH, PA, TX, and WI] and 10 retained PF regulation [AZ, CO, MA, MD, MS, MT, NC, NY, SC and TN]. Of the remaining 14 multi-LATA states excluded from the study 10 approved rate deregulation prior to 1991 [AL, ID, IL, IA, NE, ND, OK, OR, VA, and WA], two were not subject to PF regulation [CA, KY], and two have unknown (to the author) regulatory policies [GA, WV].

observations on a particular state depends on when it implemented rate deregulation.[27] Finally, to control for the correlation between the error terms across different years within the same state (i.e., state fixed effects) I include state dummy variables in the regression equation.

Based on the assumption that the regulatory policy (*DEREG*) and the regulated price (*PRICE*) are determined simultaneously, I estimate a two-equation (OLS-Logit) simultaneous system. The system is specified as

$$\begin{aligned} DEREG^{*}_{st} = a_0 + a_1 PRICE_{st} + a_2 BLINES_{st} + a_3 RURAL_{st} + a_4 BUS_{st} + \\ a_5 RES_{st} + a_6 APPT * LASTYR_{st} + a_7 ELECT * LASTYR_{st} + e_{st} \end{aligned} \tag{4.6}$$

$$PRICE_{st} = b_0 + b_1 DEREG^{*}_{st} + b_2 INCOME_{st} + b_3 LINES_{st} + b_4 ACCESS_{st} + u_{st} \tag{4.7}$$

where, $DEREG^{*}_{st}$ is a continuous variable measuring a state's unobserved propensity to deregulate; and the distribution of e_{st} and u_{st} are assumed Sech^2 and standard normal, respectively.[28] Variable definitions, their descriptive statistics and data sources are provided in Table 19.

Equation (4.6) describes the regulator's decision making process. The selection of the seven explanatory variables in this equation was informed by the variables in the model of section 4.3. Equation (4.7) describes the behavior of the regulated price. I have two comments on this equation. First, various specifications of the latter equation have been used in empirical studies of regulated industries. From the seminal work of Stigler

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[26] If the date of implementation was after June 30, the year of implementation was included in the sample, otherwise it was excluded.

[27] For comparative purposes the model was estimated using a single cross-section of 24 observations on the 24 multi-LATA states. Similar results were found. The conclusions drawn from the model - described in section IV - are unchanged. See appendix 4A

[28] Sech^2 is short for hyperbolic secant squared. See Maddala (1983), p.9.

Table 19

Variable Names, Definitions, and Descriptive Statistics

Variable	Definition	Mean	Standard Deviation	Source
PRICE	AT&T's real rate for a daytime, 100 mile, 10 minute intrastate Message Toll Service (MTS) telephone call.*	2.363	0.446	a
BLINES	Total local business (WATS) access line divided by total local access lines.+	0.697	0.043	b
OCC	The number of facility-based long-distance carriers in a state (excluding AT&T).	6.790	2.637	c
RURAL	The percentage of a state's population that is non-urban.	0.296	0.140	d
BUS	The percentage of commissioners whose past employment entailed high level business management or ownership.	0.190	0.219	e
RES	The percentage of commissioners whose past employment entailed consumer advocacy.#	0.091	0.115	e
*ELECT*LASTYR*	The percentage of a state's commissioners in the last year of their *elected* term.	0.061	0.177	e
*APPT*LASTYR*	The percentage of a state's commissioners in the last year of their *appointed* term.	0.137	0.165	e
LASTYR	The percentage of a state's commissioners in the last year of their elected or appointed term.	0.175	0.211	e
DEREG	1 if a state implemented rate deregulation in the following period, 0 if it retained PF regulation.	0.323	0.471	b
INCOME	Per capita real personal income (in thousands).%	19.141	2.681	f
ACCESS	The real access fee for a 10 minute intrastate MTS telephone call.%,^	1.177	0.382	g
LINES	The total number of local access lines divided by the state population.	0.637	0.074	b, d

Sources: (a) Tariffed MTS rates are filed with the state Public Service Commissions;

(b) FCC, *Statistics of Communications Common Carriers*, Table 2.5 (1991-97);

(c) National Association of Regulatory Utility Commissioners (NARUC), *Utility Regulatory Policy in the U.S. and Canada* (1990-96) and phone survey of commissions;

(d) U.S. Bureau of the Census;

(e) NARUC, *Yearbook of Regulatory Agencies*, Agency Profiles (1990-96);

(f) U.S. Department of Commerce, Bureau of Economic Analysis; and

(g) FCC, *ARMIS REPORTS 4308 & 4301.*

Footnotes to Table 1:

* MTS is a switched service (i.e., originates and terminates on a local telephone company's network), used primarily by small businesses and households. The real MTS price was calculated by deflating the nominal price with the consumer price index for all goods and services (i.e., the implicit price deflator).

+ Wide Access Telecom. Services (WATS) is a switched service for large volume customers.

Commissioners were categorized as consumerists if their past occupations were with the following organizations: Office of Attorney General (only in those states where the OAG operates as a consumer advocacy organization), Consumer Protection, Consumer Council, Consumer Affairs, or Legal Aid Society.

% The real price is calculated by deflating the nominal price with the implicit price deflator.

^ Access fees are charged on a per minute basis and consist of four components: (1) an originating carrier common line fee; (2) a terminating carrier common line fee; (3) a traffic sensitive fee; and (4) a non-traffic sensitive fee.

and Friedland (1962) in electricity, to Mathios and Rogers (1989) in telecommunications, it has been standard to assume that regulatory policy is exogenous.[29] Consequently, a reduced form interpretation has been applied to equation (4.7). The novelty of the equation's treatment in this paper is that regulatory policy is recognized as endogenous to the model. Thus, a two-stage estimation procedure is implemented to derive the equation's reduced form.

Second, notice that the endogenous variable *DEREG* is dependent on the firm's *expectation* of rate deregulation in the following period. Based on the assumption of rationally formed expectations, the firm's prediction of *DEREG* is the following:[30]

$$\overline{\overline{DEREG}}_{st} = DEREG_{st} + v_{st}$$

where, $\overline{\overline{DEREG}}_{st}$ is the firm's prediction of rate deregulation in the following period, conditional on the firm's contemporaneous information; and $E(v_{st}) = 0$, $E(v_{st}^2) = \sigma_u^2$. Therefore, I assume that on average the firm's prediction is accurate:

$$E(DEREG_{st}) = DEREG_{st}$$

Given the regulated carrier's extensive knowledge of the regulatory setting, this assumption appears to be appropriate. Namely, in light of the voluminous amount of public and non-public information that flows between the two parties it is likely that the regulated firm is a well informed predictor of the changes likely to occur in regulatory policy.

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[29] This could be attributed to the strict constraints of ROR regulation, to the existing theory of economic regulation, or as a simplifying assumption.
[30] See McCafferty (1990), pp.332-335.

I now describe a two-stage technique for estimating a simultaneous model where one of the dependent variables ($DEREG_{st}$) is binary.[31] The reduced form specifications of equations (4.6) and (4.7) are the following:

$$DEREG^{*}_{st} = \alpha_0 + \alpha_1 BLINES_{st} + \alpha_2 RURAL_{st} + \alpha_3 BUS_{st} + \alpha_4 RES_{st} + \alpha_5 APPT * LASTYR_{st} + \alpha_6 ELECT * LASTYR_{st} + \alpha_7 INCOME_{st} + \alpha_8 LINES_{st} + \alpha_9 ACCESS_{st} + \varepsilon_{st} \quad (4.8)$$

$$PRICE_{st} = \beta_0 + \beta_1 INCOME_{st} + \beta_2 LINES_{st} + \beta_3 ACCESS_{st} + \beta_4 BLINES_{st} + \beta_5 RURAL_{st} + \beta_6 BUS_{st} + \beta_7 RES_{st} + \beta_8 APPT * LASTYR_{st} + \beta_9 ELECT * LASTYR_{st} + \mu_{st} \quad (4.9)$$

where $DEREG^{*}_{st}$ is unobserved. Instead, $DEREG_{st}$ is observed as an indicator of $DEREG^{*}_{st}$: $DEREG_{st} = 1$ if state *s* approved rate deregulation in period *t*, 0 otherwise. Therefore, equation (4.8) becomes a logit equation. For identification purposes, the latter three explanatory variables in equation (4.8) are instruments for *PRICE*, while the latter six explanatory variables in equation (4.9) are instruments for *DEREG*.

The first stage is to estimate the reduced form logit maximum likelihood for (4.8) and OLS for (4.9). The reduced form predicted values of $PRICE_{st}$ and $DEREG^{*}_{st}$ are obtained and used as regressors in the structural equations (4.6) and (4.7). Finally, I estimate (4.6) and (4.7) using logit and OLS, respectively.

A. Description of the variables: Logit Equation (4.6)

The variables *BLINES* and *RURAL* are included to control for the impact of an interest group's size on their political support or opposition to rate deregulation. First, business consumers are the primary source of revenues used to subsidize other consumer

[31] See Maddala (1983).

groups. They tend to pay higher rates for local service and use considerably more long-distance during peak periods when rates are highest. Consequently, the business sector has almost universally supported the relaxation of regulatory controls. The variable *BLINES* measures the ratio of business to total local access lines in a state. To the extent that a larger business presence in a state increases their political support for rate deregulation, *BLINES* should be positively correlated with *DEREG*.

Second, rural residential consumers are the major recipients of cross-subsidies in this industry. All states currently require long-distance carriers to charge geographically uniform rates. Since the cost of providing service may be greater in rural than in urban areas due to density, infrastructure and geographical considerations, such a policy involves some cross-subsidization to the former from the latter. Thus, rural residential customers may be opposed to rate deregulation because they fear the loss of these subsidies. The variable *RURAL* measures the percentage of the state population classified as non-urban and is included as a proxy for rural interests in the regulatory process. To the extent that rural customers (*i*) fear rate deregulation will trigger the termination of their subsidized services, *and* (*ii*) the efficacy of their political support is enhanced by their increased presence in a state, one should observe a negative correlation between *RURAL* and the probability of rate deregulation.

RES and *BUS* are included to control for a shift in an interest group's support expenditure function. They are defined as the percentage of commissioners previously employed as (residential) consumer advocates and high level managers or business owners, respectively. The hypothesis is that prior employment controls for a regulator's bias to promote the interests of the constituent group with which he or she has prior affiliation. In turn, this bias enhances the effect of each dollar spent to promote the group's desired outcome. I describe three factors that may explain why a regulator's prior employment is helpful in predicting his or her behavior. First, *BUS* (*RES*) may control for what Gormley (1979) calls the "revolving door" hypothesis, which argues that commissioners with business (consumer advocacy) backgrounds achieve office with the objective of helping their business (consumer advocacy) allies. In return, such conduct increases the probability of securing future employment in the respective industry. Second, the variables may proxy for the ability of business (residential) consumers to appoint or elect commissioners that are biased in their favor. Third, the variable may simply reflect the type of ideological shirking in which a regulator with a business (consumer advocacy) aptitude chooses to engage.

Notice that, per the latter interpretation, *BUS* and *RES* potentially control for the presence of slack. However, to conclude that slack is the underlying motivation requires rejecting the first two interpretations. Since each interpretation is contingent on conditions unobserved by the econometrician, this precludes the feasibility of such a test. Thus, the purpose for including *BUS* and *RES* is to serve as control variables and not to corroborate a particular theory of economic regulation.

The behavior of *PRICE* is an obvious focal point in the regulatory process. Changes in the variable affect the welfare of multiple interest groups, which in turn alters the regulator's political support. As previously specified, the coefficient on *PRICE* depends on the equilibrium political support of business consumers and political opposition of residential consumers. The regulated firm's support is reflected in its manipulation of *PRICE* and the effect of this manipulation on $|\Delta W^{S}(\bullet)|$ and $|\Delta W^{O}(\bullet)|$. A negative coefficient suggests business consumer and (possibly) regulated carrier support for rate deregulation, but rejects regulatory capture by residential interest groups. A positive coefficient indicates the influence of residential consumer opposition and (possibly) regulated carrier support for rate deregulation, but rejects regulatory capture by business consumers.[32]

Finally, to proxy for the price of regulator shirking R_{SH} I include *ELECT*LASTYR* and *APPT*LASTYR*. Both are interaction variables that measure the percentage of the commissioners in the last year of their term (*LASTYR*) multiplied by the dummy variables *ELECT* and *APPT*, which equal one if a state elects or appoints its commissioners, respectively. Shirking is exhibited by the variation in regulators' motivations to act on an issue. In certain cases inaction (that is the consumption of "leisure") poses fewer risks to a politician's future than the alternative. Therefore, *ELECT*LASTYR* and *APPT*LASTYR* test for the presence of slack by controlling for the opportunity costs a regulator incurs from the consumption of leisure shirking. The hypothesis asserts that the utility derived from leisure consumption is time dependent. Assuming the value a regulator places on political support increases as the date of reelection or reappointment nears, the net gain to shirking at the beginning of a regulator's term in office should exceed that in the final year of his or her term. In short, the consumption of leisure activity should diminish as its price increases. Distinguishing

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[32] White (1996) discusses the influence of (residential) consumer interest groups in the recent deregulation of intrastate electricity. Interestingly, he found that residential interests were strongly opposed to deregulation in those states charging below average prices.

between the states that appoint and elect their commissioners does not alter the hypothesis, however the magnitude of the coefficient on *ELECT*LASTYR* is predicted to exceed that on *APPT*LASTYR*. This latter hypothesis asserts that there is greater slack in constituent control of appointed commissioners, relative to elected commissioners and this, in turn, increases the price of shirking to an elected commissioner.

B. Description of the variables: OLS Equation (4.7)

Equation (4.7) examines the causal effect of different variables on *PRICE*, defined as the real price for an AT&T 10 minute, 100 mile, daytime, Message Toll Service (MTS) telephone call.[33]

INCOME measures the state real per capita income. The hypothesis is that higher per capita income should be associated with higher demand for long-distance service and, thus, a higher price. This implies a positive coefficient on *INCOME.*

LINES measures the per capita number of local access lines in a state and is intended to capture the efficiency of a state's telecommunications infrastructure. The hypothesis is that the size of a state's infrastructure is positively correlated with its efficiency. As the network's efficiency improves, the marginal cost of providing telephone service will decline. Therefore, the hypothesis predicts that an increase in per capita lines will produce a decrease in *PRICE.*

ACCESS measures the real access fee paid by the long-distance carriers to the local telephone company for use of the local exchange network. Access fees are an

[33] MTS is a switched service (i.e., it originates and terminates on a local telephone company's network), used primarily by residential consumers and small businesses.

integral input in the production of long-distance service. Thus, a positive coefficient is predicted on *ACCESS*.

DEREG is binary variable indicating states which are rate deregulated (1) and PF regulated (0). The demonstration effect asserts that the PF regulated firm manipulates its price to promote a deregulated outcome. This suggests the relationship between *PRICE* and *DEREG* is contingent upon the equilibrium political support a regulator derives from various interest groups. Consequently, the coefficient on *DEREG* is ex-ante indeterminate. However, for the result to be consistent with the demonstration effect it must correspond with the coefficient estimate on *PRICE* in the logit equation.

4.5 Empirical Results

Tables 20 and 21 report the two-stage regression results for the OLS and Logit equations, respectively.[34,35] In the interest of saving space, estimated coefficients for the state dummy variables are left out of the body of the paper and presented in appendix 4D.

To assist in the interpretation of the results reported in Table 21 note that the probability of rate deregulation in the logit equation (4.6) is

$$P\left(DEREG_{st} = 1 \mid X^1_{st}\right) = \frac{\exp\left(X^1_{st}a\right)}{1 + \exp\left(X^1_{st}a\right)} \tag{4.10}$$

where X^1_{st} is the vector of explanatory variables and a is the vector of parameters: $a_0 - a_7$. Let $\hat{a}_i$ denote the parameter estimate on the explanatory variable X_i. Therefore, per equation (4.10) $\hat{a}_i$ reflects the extent to which an increase in the i^{th} explanatory

[34] The first-stage results for the endogenous variables *PRICE* and *DEREG* are reported in appendix 4B.

variable increases the probability that rate deregulation will be chosen relative to the probability PF regulation is retained:

$$\hat{a}_i = \frac{\partial}{\partial X_i} \log\left[\frac{P(DEREG_{st} = 1 \mid X^1_{st})}{P(DEREG_{st} = 0 \mid X^1_{st})}\right] \tag{4.11}$$

Equation (4.11) represents the change in the probability of rate deregulation that is produced by a marginal change in the independent variable X_i, ceteris paribus. Column 2 in Table 21 reports the coefficient estimates for the logit equation (4.6), while column 3 reports the $\hat{a}_i$ coefficients as described in equation (4.11).

Those coefficients for which a hypothesis is expressed and which attain statistical significance exhibit the expected sign, and the overall equations are significant in explaining *PRICE* (F-statistic = 107.61) and *DEREG* (chi2(30) = 62.89). Moreover, the goodness-of-fit of the equations, given by the pseudo-R^2 = 0.727 in equation (4.6) and the R^2 = 0.985 in equation (4.7), is impressive.[36] Finally, the percent of correct predictions in equation (4.6) is 71.

Begin with Table 20. The coefficient estimate for *INCOME* is 1.04 (st. error = 0.47), which conforms with the prediction that an increase in demand, produced by a rise in per capita income, causes an increase in the price. The coefficient on *ACCESS* is 0.45 (st. error = 0.12), which also agrees with its hypothesized effect, namely, that an increase

[35] For a related analysis of the diffusion of rate deregulation in the intrastate markets see the OLS-Tobit results reported in appendix 4C. While similar to the regulatory choice model, the diffusion model's focus is on the variation between early and late adopting states.

[36] If we let $\ln L(\hat{a}_{H_1})$ represent the value of the log-likelihood function evaluated at the parameter estimates and $\ln L(\hat{a}_{H_0})$ be the value of the log-likelihood function evaluated under the null hypothesis, i.e., the parameters are zero, then the pseudo-R^2 is given by $1 - \ln L(\hat{a}_{H_1}) / \ln L(\hat{a}_{H_0})$. See StataCorp. (1995), Vol. 1, p.366.

Table 20
Two-Stage Estimates: OLS Equation
Dependent Variable: *PRICE*
(standard errors in parentheses)

	Coefficient Estimates
Intercept	2.070**
	(0.610)
DEREG	-0.132**
	(0.033)
INCOME	1.044**
	(0.470)
ACCESS	0.447**
	(0.120)
LINES	-0.729
	(0.458)
State Dummy Variables	YES
Number of Observations	83
F statistic	107.61
R-Squared	0.9849
Adjusted R-Squared	0.9757

* Significant at the 10 % level.
** Signifcant at the 5 % level.

in the price of a key input has a positive impact on the price of long-distance service. The coefficient on *LINES* is –0.73 (st. error = 0.46) which is the expected sign but statistically and economically insignificant; a 10 percent increase in the number of per capita local access line is predicted to produce a 0.13 percent reduction in *PRICE*.

Finally, the coefficient on *DEREG* is –0.13 (st. error = 0.03), indicating that PSC approval of rate deregulation produced a decline in AT&T's price. This result, in conjunction with the coefficient on *PRICE* in equation (4.6), corroborates the demonstration effect. In itself, it suggests that in the period preceding implementation of rate deregulation, factors unrelated to supply and demand caused the state's regulated price to be lower than the price in (*i*) prior periods and/or (*ii*) states that retained PF regulation.

Given their intuitive interpretation, the discussion that follows refers to the values in column 3 of Table 21. Support for the hypothesis that group size is positively correlated with the group's interests is found in the positive coefficient on *BLINES*. In states where the percentage of business local access lines is one standard deviation above the sample mean, the probability of rate deregulation is 2.23 times more likely (st. error = 0.95). Since business customers are the primary contributors of cross-subsidies in this industry, this result reflects business consumers strong predilection for rate deregulation.

The coefficients on the interest group variables *RURAL* is inconclusive: it contradicts its hypothesized interest group effect, yet fails to reach statistical significance. In any event, the coefficient is of a fairly small magnitude; a 10 percent increase predicts a 4 percent increase in the probability of rate deregulation. The failure of rural to

Table 21
Two-Stage Estimates: Logit Equation
Dependent Variable: *DEREG*
(standard errors in parentheses)+

	Coefficient Estimates	The Impact of Changes in the Explanatory Variables on the Estimated Probability of Rate Deregulation
Intercept	39.177 (71.336)	--
PRICE	-6.531** (2.927)	-2.343** (1.050)
BLINES	6.225** (2.645)	2.234** (0.949)
RURAL	1.103 (7.287)	0.396 (0.2.615)
BUS	6.189** (2.894)	2.221** (1.039)
RES	-10.538** (4.009)	-3.781** (1.439)
LASTYR	8.242** (3.017)	2.957** (1.082)
State Dummies Variables	YES	YES
Observations	83	
Chi-Sq (30 DF)	62.89	
Pseudo R-Sq	0.7266	
Percent Correct Prediction	71	

+ The delta-method [See Greene p.297] used to derive st. errors in column 3.
* Significant at the 10 % level.
** Signifcant at the 5 % level.

accurately predict rate deregulation suggests that rural customers (*i*) do not fear that mandatory rate-averaging is threatened by the elimination of PF regulation and/or (*ii*) the efficacy of their political support is not enhanced by their increased presence in a state.

The positive coefficients on *BUS* 2.22 (st. error = 1.04) and negative coefficient on *RES* –3.78 (st. error = 1.44) indicate that the prior employment of commissioners plays an important role in predicting regulatory change. This confirms the hypothesis that a regulator's origins are helpful in predicting his or her current behavior. A consequence of this predictability is that it reduces the expenditures necessary to promote an interest group's agenda and thus has a positive impact on their political support or opposition to rate deregulation. Unfortunately, the underlying explanation for this regulator bias (i.e., the revolving door, interest group influence, or regulator shirking) is not observed. Thus, while this result is of empirical interest it cannot be used to test for the presence of slack.[37]

Support for the presence of slack is found in the coefficient on *LASTYR*. Initially, both *ELECT*LASTYR* and *APPT*LASTYR* were included in the logit regression. However, the second of two hypotheses tested on the variables was rejected: there was no evidence of greater slack in a constituent's control of an appointed commissioner, relative to an elected commissioner. While the coefficient estimates on both variables were positive and jointly significant, the variation in their point estimates was statistically

[37] Notice that the exogeneity of *BUS* and *RES* is likely contingent upon their interpretation. To the extent that they proxy for the influence of business and residential consumer interests the assumption may be inappropriate. Fortunately, their inclusion in the model is not integral to achieving the paper's objectives. While excluding *BUS* and *RES* from the logit equation reduces its goodness-of-fit (from 0.73 to 0.52), the results are similar. Most importantly, the papers two fundamental conclusions - the presence of slack and strategic firm behavior - are unchanged.

insignificant.[38] This result suggests that the electoral and appointment processes were equally (in)effective in constraining a regulator's non-political support behavior.

For efficiency reasons, I pooled *ELECT*LASTYR* and *APPT*LASTYR*, formulating a single variable *LASTYR*. The restricted logit regression results including *LASTYR* are reported in table 21, while the unrestricted logit regression results including *ELECT*LASTYR* and *APPT*LASTYR* are reported in appendix 4E. *LASTYR* had a marked positive impact on the model: the goodness of fit, as reflected in the pseudo-R^2, increased to 0.727 from 0.601 upon the inclusion of the variable; and the coefficients sign was positive and statistically significant. The latter result supports the hypothesis that a change in the price of shirking has a negative impact on the regulator's consumption of shirking and the political support for rate deregulation, and a positive impact on the political opposition to rate deregulation.

Finally, the coefficient on *PRICE* indicates that as the variable increases above its sample mean by one standard deviation a state became 2.34 times less likely to approve rate deregulation (st. error = 1.05). Two conclusions are drawn from this result. First, this outcome rejects the hypothesis of residential consumer capture, but fails to reject the hypothesis of regulatory capture by business consumers and (possibly) the regulated firm. Second, in conjunction with the negative coefficient estimate on *PRICE* in equation (4.7), this result is consistent with the demonstration effect hypothesis.

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[38] The Chi-squared statistic for the hypothesis that the coefficient on *APPT*LASTYR* equals the coefficient on *ELECT*LASTYR* is 7.34

4.6 Conclusion

In summary, I investigated the likelihood that a state adopts rate deregulation in place of PF regulation in the intrastate long-distance markets. An interest group rent-seeking explanation is supported by the coefficient on *BLINES*: the intensity of business usage in a state, as captured in the percentage of business local access lines, is positively correlated with the probability of rate deregulation.

In addition, a test for the presence of slack is confirmed. First, while the method of achieving office (elect vs. appoint) does not appear to produce variation in regulator slack, the year in a regulator's term of office did affect his or her consumption of shirking. The hypothesis on the variable *LASTYR* asserts that the value a regulator receives from the political support of constituents increases, and conversely the utility derived from the consumption of shirking decreases, in the year of reelection or reappointment. Consequently, the greater opportunity costs of maintaining the status quo PF policy during this year increases the probability that a state chooses rate deregulation. The positive coefficients *LASTYR* supports this hypothesis.

I also cannot reject the demonstration effect hypothesis. The negative coefficient on *PRICE* in the logit equation in conjunction with the negative coefficient on *DEREG* in the OLS equation, suggests the strategic firm behavior plays a significant role in predicting regulatory change.

Finally, the prior employment characteristics of a regulator were important. The paper examines two categories of employment: (residential) consumer advocacy (*RES*) and senior level business management or ownership (*BUS*). The hypothesis is that a regulator's actions are biased towards interest groups with which he or she has had prior affiliation. The negative coefficient on *RES* and positive coefficient on *BUS* support this hypothesis. Unfortunately, it was not possible to attach an unambiguous political support or slack interpretation to these variables. Thus, while uncovering an interesting relationship, they do not corroborate a particular theory of economic regulation.

Although this research cannot be interpreted as a completely unambiguous test of the theories of economic regulation, it does lend empirical support to the fundamental premise that regulatory bodies are responsive not only to rent-seeking interest groups, but also to their consumption demands for shirking activity. Moreover, it does help to explain the surprisingly rapid pace of deregulation of the industry. In light of the number of factors encouraging this trend (e.g., regulator affiliation, the year in their term of office, the intensity of business usage, and the demonstration effect), the real surprise may be that state level long-distance telecommunications regulation is still present at all.

Appendix 4A

Estimation Results – Cross-section Data – Regulatory Choice System

Data: The data comprise a single cross-section of 24 observations on the same 24 multi-LATA states used estimate regulatory choice system [equations (4.6) and (4.7)]. Note that the independent variables used to predict the diffusion of rate deregulation are likely affected by the change in their regulatory environment. To eliminate this endogeneity problem I include measures of the variables during the year rate deregulation was approved. For those states that retained PF regulation I take the average of the variables between 1991-95.

Table 22
Variable Descriptive Statistics

Variable	Mean	Standard Deviation
PRICE	2.099	0.413
BLINES	0.691	0.044
OCC	6.600	2.661
RURAL	0.288	0.139
BUS	0.199	0.229
RES	0.129	0.189
*ELECT*LASTYR*	0.027	0.080
*APPT*LASTYR*	0.180	0.192
DEREG	0.583	0.504
YEARS	1.84	1.546
INCOME	19.564	2.830
ACCESS	1.044	0.343
LINES	0.528	0.133

Table 23
Two-Stage Estimates: OLS Equation
Dependent Variable: *PRICE*
(standard errors in parentheses)

	Coefficient Estimates
Intercept	1.364
	(0.933)
DEREG	-0.239*
	(0.136)
INCOME	0.009*
	(0.005)
ACCESS	0.582**
	(0.194)
LINES	-0.236
	(0.530)
Number of Observations	24
F statistic	5.15
R-Squared	0.5754
Adjusted R-Squared	0.4636

* Significant at the 10 % level.
** Signifcant at the 5 % level.

Table 24
Two-Stage Estimates: Logit Equation
Dependent Variable: *DEREG*
(standard errors in parentheses)+

	Coefficient Estimates	The Impact of Changes in the Explanatory Variables on the Estimated Probability of Rate Deregulation
Intercept	-11.215 (12.588)	--
PRICE	-1.749 (1.583)	-0.676 (0.612)
BLINES	19.399** (7.843)	7.495** (3.030)
OCC	-0.0714 (0.252)	-0.028 (0.097)
RURAL	-0.104 (0.235)	-0.040 (0.091)
BUS	1.953 (2.384)	0.754 (0.921)
RES	-8.808* (4.701)	-3.403* (1.816)
*APPT*LASTYR*	10.955* (6.174)	4.232* (2.385)
*ELECT*LASTYR*	7.169 (12.812)	2.770 (4.950)
Observations	24	
Chi-Sq (9 DF)	22.40	
Pseudo R-Sq	0.6657	
Percent Correct Prediction	64	

+ The delta-method [See Greene p.297] used to derive st. errors in column 3.
* Significant at the 10 % level.
** Signifcant at the 5 % level.

Appendix 4B

First Stage Regression Results – Panel Data – Regulatory Choice System

Table 25
First-Stage Estimates
(standard errors in parentheses)

Dependent Variable =	*PRICE*	*DEREG*
Independent Variable	Coefficient (standard error)	Coefficient (standard error)
Intercept	1.281 (2.083)	-2.991 (7.084)
INCOME	0.020 (0.022)	-0.467* (0.256)
ACCESS	0.516** (0.124)	-2.700** (1.173)
LINES	-0.898* (0.499)	13.338 (10.476)
BLINES	3.482 (3.515)	9.206* (4.743)
OCC	0.031** (0.010)	0.050 (0.102)
RURAL	0.401 (1.011)	1.691 (0.430)
BUS	-0.276** (0.122)	4.730** (1.564)
RES	0.113 (0.240)	-8.510** (3.673)
*APPT*LASTYR*	0.155** (0.073)	6.817** (2.200)
*ELECT*LASTYR*	0.060 (0.089)	4.806* (2.611)
State Dummy Variables	YES	YES
Observations	83	83
F-stat / Chi-Sq	52.86	58.83
R-sq / Pseudo R-Sq	0.9796	0.7545

* Significant at the 10 % level.
** Signifcant at the 5 % level.

Appendix 4C

Estimation Results – Cross-section Data – Diffusion System

Objective: Examine the variation between those states that were early and late adopters of rate deregulation.

Simultaneous Equations System: OLS-Tobit. The system's specification is identical to that of the regulatory choice model except that $DEREG_{St}$ - the dependent variable in (4.6) and independent variable in (4.7) - is replaced with $YEARS_S$, defined as the years, prior to year-end 1996, since a state implemented rate deregulation. The censored nature of $YEARS_s$, namely the clustering of observations around zero, requires the implementation of a tobit estimation procedure.[39] The OLS-Tobit model of diffusion is specified as

$$\begin{aligned} YEARS_s &= c_0 + c_1 PRICE_s + c_2 BLINES_s + c_3 RURAL_s + c_4 OCC_s + \\ &\quad c_5 BUS_s + c_6 CONS_s + c_7 ELECT * LASTYR_s + c_7 APPT * LASTYR_s + c_8 TERM_s + n_s \end{aligned} \tag{4.1C}$$

$$\begin{aligned} PRICE_s &= d_0 + d_1 YEARS_s + d_2 INCOME_s + d_3 UNEMPLOY_s + \\ &\quad d_4 LINES_s + d_5 ACCESS_s + w_s \end{aligned} \tag{4.2C}$$

Each equation contains one endogenous independent variable – $PRICE_S$ and $YEARS_S$; all others are assumed exogenous. The variables descriptive statistics are provided in Table 22.

Data: The data comprise a single cross-section of 24 observations on the same 24 multi-LATA states used estimate regulatory choice system [equations (4.6) and (4.7)]. Note

[39] The tobit equation is based on a truncated distribution; that is, the dependent variable is prohibited or censored from falling below a specified value – in this case zero. Tobin (1958) was the first econometric study to examine this issue. The model's title is in recognition of the author's contribution.

that the independent variables used to predict the diffusion of rate deregulation are likely affected by the change in their regulatory environment. To eliminate this endogeneity problem I include measures of the variables during the year rate deregulation was approved. For those states that retained PF regulation I take the average of the variables between 1991-95.

Estimation Technique: Maddala (1983) describes a two-stage technique for estimating a simultaneous model where one of the dependent variables is censored. In condensed notation I rewrite the system as

$$YEARS_s^* = \chi_1 PRICE_s + \chi_2 X_s^1 + n_s \tag{4.1C}$$

$$PRICE_s = \delta_1 YEARS_s^* + \delta_2 X_s^2 + w_s \tag{4.2C}$$

where $YEARS_{st}^*$ is a continuous variables measuring the years since deregulation; and X_s^1 & X_s^2 are the exogenous variables. In reduced form the system is written

$$YEARS_s^* = \Pi_s^1 X_s + \eta_s \tag{4.3C}$$

$$PRICE_s = \Pi_s^2 X_s + \varpi_s \tag{4.4C}$$

where $YEARS_s^*$ is censored. Instead, $YEARS_s$ is observed as an indicator of $YEARS_s^*$, where $YEARS_s = YEARS_s^*$ if $YEARS_s^*$ > 0, 0 otherwise. Therefore, (4.3C) becomes a tobit equation.

The first stage is to estimate the reduced form tobit maximum likelihood for (4.3C) and OLS for (4.4C). The reduced form predicted values of $PRICE_s$ and $YEARS_s^*$ are obtained and used as regressors in the structural models. Finally, the structural equations are estimated using tobit for (4.1C) and OLS for (4.2C).

Table 26
Two-Stage Estimates: Tobit Equation
Dependent Variable: *YEARS*
(standard errors in parentheses)

	Coefficient Estimates
Intercept	-7.606
	(6.969)
PRICE	-0.275
	(0.394)
BLINES	9.621**
	(2.981)
OCC	0.410
	(0.251)
RURAL	-0.605
	(2.794)
BUS	2.528*
	(1.273)
RES	-8.299**
	(2.759)
*ELECT*LASTYR*	6.056
	(7.476)
*APPT*LASTYR*	3.466**
	(0.958)
Number of Observations	24
Chi2(9 DF)	28.67
Pseudo R-Squared	0.3261

* Significant at the 10 % level.
** Signifcant at the 5 % level.

Table 27
Two-Stage Estimates: OLS Equation
Dependent Variable: *PRICE*
(standard errors in parentheses)

	Coefficient Estimates
Intercept	1.736 (1.049)
YEARS	-0.060 (0.052)
INCOME	1.017** (0.581)
ACCESS	0.533** (0.209)
LINES	-0.109 (0.545)
Number of Observations	24
F statistic	4.42
R-Squared	0.5379
Adjusted R-Squared	0.3931

* Significant at the 10 % level.
** Signifcant at the 5 % level.

Appendix 4D

Estimation Results – Panel Data – Regulatory Choice System State Fixed Effects

Table 28

Two-Stage Estimates: State Dummy Variables+

(standard errors in parentheses)

	Logit Equation (3)	OLS Equation (4)
1. Arizona	Omitted	Omitted
2. Arkansas	0.901 (1.689)	0.196** (0.068)
3. Colorado	-5.132 (3.120)	-0.105 (0.095)
4. Florida	-1.150 (6.232)	-0.169 (0.191)
5. Indiana	0.683 (2.661)	-0.473* (0.255)
6. Kansas	-8.701 (5.973)	-0.009 (0.162)
7. Louisiana	-36.499** (15.384)	-0.357** (0.078)
8. Massachusetts	-9.559 (11.107)	0.280 (0.357)
9. Maryland	-29.186** (12.720)	-0.091 (0.312)
10. Michigan	0.741 (1.556)	0.662** (0.171)
11. Minnesota	-2.112 (2.040)	0.112 (0.233)
12. Mississippi	1.653 (7.822)	-0.497** (0.122)
13. Missouri	0.980 (3.213)	0.282** (0.133)
14. Montana	6.878* (3.767)	-0.286** (0.066)
15. New Jersey	-25.401* (13.790)	0.169 (0.435)
16. New York	-4.987 (6.007)	-0.168* (0.088)
17. Nevada	-29.076** (11.154)	-0.084 (0.238)
18. North Carolina	0.673* (0.359)	-0.097 (0.108)
19. Ohio	1.275 (4.005)	0.154 (0.142)
20. Pennsylvania	1.232 (5.765)	0.551** (0.207)
21. South Carolina	2.914 (4.100)	0.019 (0.106)
22. Tennessee	1.001 (0.759)	0.218 (0.665)
23. Texas	-9.870 (4.114)	-0.043 (0.126)
24. Wisconsin	2.863 (4.980)	-0.012 (0.145)

+ While the F statistic of 43.12 confirmed the hypothesis that state fixed effects are jointly significant in equation (4), the Chi-squared statistic of 7.41 for equation (3) fails to reject the joint significance of state fixed effects.
* Significant at the 10 % level; ** Signifcant at the 5 % level.

Appendix 4E

Estimation Results – Panel Data – Unrestricted Logit Equation

Table 29
Two-Stage Estimates: Unrestricted Logit Equation
Dependent Variable: *DEREG*
(standard errors in parentheses)+

	Coefficient Estimates	The Impact of Changes in the Explanatory Variables on the Estimated Probability of Rate Deregulation
Intercept	19.673	--
	(39.099)	
PRICE	-3.654**	-1.131**
	(1.714)	(0.531)
BLINES	6.012**	2.157**
	(2.611)	(0.937)
RURAL	-0.707	-0.254
	(4.719)	(1.693)
BUS	6.310**	2.221**
	(2.733)	(1.039)
RES	-15.644**	-3.781**
	(8.409)	(1.439)
*ELECT*LASTYR*	7.928**	2.845**
	(4.082)	(1.465)
*APPT*LASTYR*	6.503**	2.333**
	(2.414)	(0.866)
State Dummies Variables	YES	YES
Observations	83	
Chi-Sq (31 DF)	62.74	
Pseudo R-Sq	0.7249	
Percent Correct Prediction	69	

+ The delta-method [See Greene p.297] used to derive st. errors in column 3.
* Significant at the 10 % level.
** Signifcant at the 5 % level.

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