Regulated Prices with Competition and Heterogeneous Consumers*

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Abstract

This paper studies how the political influence of consumer groups and firms affects the behavior of state regulators and in turn the effectiveness of federal policies. We employ a unique granular data set for U.S. local telephone markets to examine empirically differences in state and intrastate characteristics that identify regulators' pricing decisions with competition and heterogeneous consumers. Results show that state regulators take into account the overall structure of prices within a state when setting prices for a particular service in specific regions. We find that state regulators consider the direct and opportunity cost of service provision when setting prices, and follow a "share the pain" method of dealing with higher rural costs by increasing all prices across the state. In addition, they use federal universal service subsidies to reduce urban business prices rather than to reduce prices in the rural wire centers to which they are targeted. Removal of local entry barriers and incumbent line-of-business restrictions is associated with a 20 percent decrease in urban business prices and almost a six percent increase in urban residential prices.

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I. Introduction

U.S. policy makers began restructuring communications, energy and transportation in the late 1970's with the intention of letting markets instead of regulators largely determine resource allocation. Market restructuring and technology change have enabled competitive alternative to these previously regulated monopoly networks to serve consumers with different preferences and different costs of service provision.[1] The ostensible deregulation of network industries actually involves continuing government intervention and oversight, with the threat of more future regulatory involvement. This paper studies how the political influence of different consumer groups and firms affects the behavior of state regulators.

Recent theories of network interconnection, such as the Efficient Component Pricing Rule ("ECPR") and Total Element Long Run Incremental Cost (TELRIC), propose rules that allow new entrants to compete with incumbents for retail services by accessing essential facilities efficiently (Willig, 1979; Baumol, 1983; Baumol and Sidak, 1994; Laffont and Tirole, 1994; Armstrong et. al., 1996; Farrell, 1996; and Vogelsang, 2002). Regulatory intervention in the form of mandated access pricing is intended to foster retail competition for consumers while avoiding inefficient bypass. In practice, regulators face pressure from different consumer groups, regulated incumbents and unregulated competitors regarding prices for wholesale services, the extent of entry, and how entry affects retail prices and product offerings. Common costs or cross subsidies tie groups together in the regulatory process. Differences in prices and competition

[1] See Joskow (1997), Kraft and Harris (1997) and Peltzman and Winston (2000) for additional discussion of network deregulation. Borenstein et al. (2002) discuss how deregulation may not lead to the market results intended.

available to one group of consumers can affect other groups of customers through the regulated firm's profit constraint.

The observation that common costs and cross subsidy lead to tension between different groups is not novel.[2] Several studies provide empirical evidence to support the long-held belief that urban customers, primarily business customers, subsidize rural, residential customers in the provision of utilities (Naughton, 1986; Noll and Smart, 1991; Palmer, 1992; Maher, 1999). Kaserman et al. (1990) find that subsidy dollars transferred from intrastate long-distance to local telephone companies do not lower local residential prices.[3] Eriksson et al. (1998) show the same subsidy dollars lower local residential telephone prices but have no direct impact on demand. Steiner (2004) finds a significant increase in the ratio of residential to business prices following the restructuring of electricity markets. Knittle (2004) shows an increase in competition is associated with a reduction of cross subsidization from business to residential local telephone prices. Hausman et. al. (2002) find that, following the easing of barriers to entry in long-distance and local telephone markets in 1996, new entrants gained substantial market share in local markets. However, there is no significant change in local residential prices.[4]

We extend these studies by using the interest group theory of regulation (Stigler, 1971; Peltzman, 1976; and Noll, 1989) to model formally the trade offs faced by state

[2] Differences in political constituencies also leads to tension between federal and state regulators. For example, Iowa sued the FCC over rules adopted by the FCC to implement the Telecom Act of 1996 *Iowa Utilities Board v. FCC* 525 U.S. 366 (1999).

[3] Riordan (2002) cautions that the term cross subsidy is often used loosely, ignores the potential impact network externalities and economies of scale have on efficient pricing of services, and that examples of urban-to-rural and business-to-residential cross subsidies often ignore profits from unregulated services, such as call waiting and other vertical features.

[4] Related studies examine the relationship between political and regulatory variables and entry in local telephone markets. Abel (2002) finds markets with price-cap regulation see less entry. De Figueiredo, Jr. and Edwards (2004) show a negative association between the political contributions of new entrants and access prices. Greenstein and Mazzeo (2004) provide evidence that suggests lower access prices attract new entrants with a "national presence" rather than entrants with a "local/regional presence" and that changes in prices also affected entry decisions.

regulators, and to account for the tension between incumbents and new entrants about the pricing of inputs. Model implications are then applied to a unique granular data set to examine empirically how different forces affect regulators' pricing decisions with competition and heterogeneous consumer preferences. An important advantage of our data and estimation strategy is that we control for the relationship between retail prices for different customer groups within and between regions, as suggested by theory. Disaggregated data also permit estimation of the impact national policies have on intra-state constituencies.

We use a data set for U.S. local telephone prices in 2002 for the Regional Bell Operating Companies (RBOCs), six years after Congress passed the Telecommunications Act of 1996 ("Telecom Act"), for the empirical analysis. The Telecom Act requires state regulators to establish cost-based wholesale prices for incumbent facilities.[5] State regulators are also responsible for setting retail prices, and for programs that continue to support the social policy of affordable, universal telephone service in a competitive market.[6] The addition of a cost-based, wholesale access requirement puts at risk the historical practice of using implicit cross subsidies from business and urban customers to keep residential and rural prices below cost. Over time, if entry is successful, regulators will be forced to move prices in line with costs to ensure incumbent solvency.

Data from the period following the passage of the Telecom Act provides an opportunity to examine empirically differences in state and intrastate characteristics that

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[5] "Large" incumbents must lease all or portions of their networks to competitors (known as "unbundled network elements" (UNEs)), and new entrants are allowed to buy and resell incumbent services in the retail market (known as "reselling"). Furthermore, state regulators are restricted from barring competition.

[6] State regulators assist the administration of a federal universal service fund (USF) intended to advance the availability of services to all consumers, including those in low-income, rural, insular, and high-cost areas at prices that are reasonably comparable to those charged in urban areas. All providers of telecom services are required to contribute to the federal USF in an equitable and nondiscriminatory manner.

influence regulators' pricing behavior. By controlling for the overall structure of prices and costs within a state, and the political influence of interest groups, we estimate the effect federally-mandated rules have on local prices. In particular, we examine the extent to which state regulators' pricing guidelines reflect the direct and opportunity cost of service provision, and whether a billion-dollar federal universal service fund (USF), intended to promote universal telephone service in large telephone companies' rural regions, lowers rural prices.[7] Furthermore, we investigate how the removal of local entry barriers and line-of-business restrictions ("271 approval") to incumbent RBOCs affect retail and access prices.[8]

Estimation results show that regulators take into account the overall structure of prices within a state when setting prices for a particular service in specific regions. Aggregated studies that rely on state-average prices, and/or ignore rural areas, may be misleading as they do not capture the political process followed by regulators when setting prices. For example, we find that the empirical evidence consistent with implicit cross subsidization from business to residential consumers in urban areas is substantially weakened when we control for rural residential prices and federal rural subsidy programs. The results also show that while universal service subsidies targeted for high-cost, rural regions have little effect on prices in these areas, the subsidies correlate with lower urban business prices. 271 approval is associated with a 20 percent decrease in urban business

[7] In particular, we examine the effect support to "non-rural" companies, where non-rural companies are relatively large carriers. This paper does not examine the effect USF support has on small, or in FCC parlance, "rural" companies. Total non-rural federal universal support in 2002 was $840 million. USAC estimates that total USF collections for the second quarter 2005 equaled approximately $1,8 billion, of which $1,015 million goes to high-cost support (about $207 million goes to low-income support, $577 million to schools and libraries, and $6 million to rural health care).

[8] The Telecom Act removes RBOC line-of-business restrictions once the RBOC satisfies a "competitive checklist" listed in Section 271. The checklist aims to ensure that the local market in an applicant RBOC's state is open to facilities-based and resale competition, and the purchasing of UNEs.

prices and almost a six percent increase in urban residential prices. State regulators respond to political contributions, their political affiliation affects prices, and, to some extent, regulators consider the revenue incumbents lose when competitors serve customers using leased network elements to price network access. The paper is organized as follows. Section II provides a theoretical framework that shows how regulated prices for different services and regions within a state are related. Section III describes the data and variables used to estimate our empirical model. Results are discussed in Section IV, and Section V provides conclusions.

II. Theoretical Discussion

Below, we outline a theoretical framework to gain insight into how interest groups affect regulators' pricing decisions, and how prices within a state are related. The framework describes the economic and institutional features of a partially deregulated market in terms of the dominant-firm, competitive-fringe (DFCF) model. The DFCF assumption permits us to abstract away from strategic behavior between the incumbent and new entrant(s) and focus more clearly on regulators' actions. The incumbent owns an essential facility to which new entrants require access to produce a competing retail service.[9] Regulators choose retail and access prices to maximize their utility, which is a function of the surplus customer groups receive from different regional markets within the state, subject to the regulated firm's profit constraint. The weights regulators attach

[9] We note there may be alternatives to using the pieces of the incumbent network to provide competing services such as wireless service in the case of voice telephony. However, even facilities-based competitors generally require some interconnection with the incumbent network.

to specific surpluses are affected by the political influence of the various customer groups and regions.[10]

A. Dominant firm-competitive fringe

We first describe market structure and profit determination by generalizing Armstrong et al.'s (1996) access pricing model to multiple customer groups and regions. A regulated incumbent firm with an essential facility competes with a fringe of new entrants for consumer groups $k = 1, \ldots, K$ in regions $m = 1, \ldots, M$. Fringe firms are identical and produce a homogenous service within class k using the essential facility of the upstream incumbent and other inputs.[11] Aggregate fringe supply has constant marginal cost $c_{km}(a_m)$ in region m and minimum total cost $c_{km}q_{km}$, where a_m is the wholesale price paid to access the essential facility, q_{km} denotes fringe output, $\frac{\partial c_{km}}{\partial a_m} \geq 0$ and $\frac{\partial^2 c_{km}}{\partial a_m{}^2} \leq 0$. If fringe firms cannot substitute away from the incumbent's input, and must use one unit of access to provide one unit of service, $\frac{\partial c_{km}}{\partial a_m} = 1$. All fringe firms compete with the incumbent as if they are a single firm, and competition among fringe firms drives fringe retail prices to cost, $p_{km} = c_{km}(a_m)$. Using Shephard's Lemma, fringe demand for access to the essential facility is $q^a_{km} = \frac{\partial c_{km}}{\partial a_m} q_{km}(P_{km}, p_{km}(a_m))$, where P_{km} is the incumbent's price. Incumbent profit from serving group k in region i is:

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[10] In addition to the profit constraint, political contributions by the incumbent and entrant can be viewed in the context of the model as an attempt to influence the supply of regulation. Incumbents use contributions to lobby for a higher access price and higher marginal cost for new entrants. New entrants desire a low access price so as to gain market share quickly and a sufficient subscriber base to justify investment in own facilities and other services such as the Internet, long-distance, etc.

[11] Lower case letters denote fringe variables and upper case letters denote the incumbent.

$$\Pi_{km}(P_{km}, p_{km}(a_m)) = \left(P_{km} - C_{km}\right) Q_{km}\left(P_{km}, p_{km}(a_m)\right) + \left(a_m - C^a_{km}\right) q^a_{km}(a_m) \qquad (1)$$

where C_{km} and C^a_{km} are the incumbent's constant marginal cost's of supplying the retail service and essential facility, respectively, and Q_{km} is the incumbent's retail output.

B. Interest group theory of regulation

Interest groups influence the political environment so that regulators give preferential treatment to certain customers and regions through their pricing guidelines. In the spirit of Peltzman's (1976) interest group theory of regulation,[12] regulators' utility (U) is a function of prices charged to customer groups and their political influence:

$$U = U\left(V_{11}(P_{11}, p_{11}(a_1)), V_{12}(P_{12}, p_{12}(a_2)), \ldots, V_{KM}(P_{KM}, p_{KM}(a_M))\right) \qquad (2)$$

where V_{km} is consumer surplus for group k in region i and $\frac{\partial U}{\partial V_{km}} \geq 0$ measures the political influence of this group.[13] Utility is quasi-concave in P_{km} and p_{km} and both $\frac{\partial U}{\partial P_{km}} = \frac{\partial U}{\partial V_{km}} \frac{\partial V_{km}}{\partial P_{km}} \leq 0$ and $\frac{\partial U}{\partial p_{km}} = \frac{\partial U}{\partial V_{km}} \frac{\partial V_{km}}{\partial p_{km}} \leq 0$ decrease with the strength of political influence $\frac{\partial U}{\partial V_{km}}$. Furthermore, both $\frac{\partial U}{\partial P_{ln}}$ and $\frac{\partial U}{\partial p_{ln}}$ increase with $\frac{\partial U}{\partial V_{km}} (\in n \neq m \text{ or } l \neq k)$ since an increase in the political influence of one group decreases the influence of others. The regulator simultaneously chooses prices for each group and region to maximize utility subject to the constraint that the incumbent's total profit from all regions equals some amount $\overline{\Pi}$. The optimization problem is:

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[12] Feldstein (1972) and Ross (1984) develop theoretical models where the regulators objective is to maximize weighted social welfare functions.

[13] We recognize the interest group theory of regulation focuses mainly on the demand for regulation. In the empirical estimation we control for characteristics that affect the supply of regulation such as the relationship between politicians and regulators, political affiliation and method of appointment.

$$\max U\left(V_{11}(P_{11}, p_{11}(a_1)), V_{12}(P_{12}, p_{12}(a_2)), \ldots, V_{KM}(P_{KM}, p_{KM}(a_M))\right)$$
$$\text{subject to} \sum_{k=1}^{K}\sum_{m=1}^{M} \Pi_{km}\left(P_{km}, p_{km}(a_m)\right) = \overline{\Pi} \tag{3}$$

For easier explanation, we examine two special cases. *Case (i)* assumes two customer groups *k* = R, B, potentially representing residential and business customers, respectively, and one region, *m*. The regulator has three choice variables, P_{Rm}, P_{Bm} and a_m. The equilibrium condition for prices P_{Rm} and P_{Bm} is obtained by equating first-order conditions to eliminate λ, where $\lambda > 0$ is the shadow price of the profit constraint. Here, the regulator chooses equilibrium retail prices for R and B customer groups to satisfy:

$$\frac{\partial U / \partial P_{Rm}}{\partial U / \partial P_{Bm}} = \frac{\partial \Pi_{Rm} / \partial P_{Rm}}{\partial \Pi_{Bm} / \partial P_{Bm}} \tag{4}$$

In equilibrium, profit constraints require regulators to trade off price reductions to group R with price increases to group B. When the constraint is binding, profits are concave in prices. An increase in the political influence of group R increases the left-hand side of equation (4) and P_{Rm} (P_{Bm}) must fall (rise) to restore equilibrium. The equilibrium condition is easily extended to multiple regions in *case (ii)* which assumes one customer group *k* and two regions *m* = 1, 2 (or perhaps, urban and rural regions, respectively). The equilibrium condition for retail prices in region's one and two is:

$$\frac{\partial U / \partial P_{k1}}{\partial U / \partial P_{k2}} = \frac{\partial \Pi_{k1} / \partial P_{k1}}{\partial \Pi_{k2} / \partial P_{k2}} \tag{5}$$

When region one's political influence increases, P_{1k} (P_{2k}) must fall (rise) to restore the equilibrium in (5). In effect, (4) and (5) imply that observed levels of cross-subsidy are determined by the economic and political strength of opposing groups in different regions and the costs of providing service to them. The condition denoted in equation (5) also implies that adverse cost shocks to one group may be transmitted across all groups in the form of higher prices – Peltzman's (1976) "share the pain" argument. In the empirical estimation below, we generalize the model to multiple customer groups and multiple regions at the same time.

C. Price-cost markup equations

More explanation of the factors that affect regulators' pricing decisions is obtained by re-arranging the first-order conditions for maximizing (3) into a system of price-cost markup equations. In *case (i)*, the first-order conditions with respect to P_{Rm} , P_{Bm} and a_m imply:

$$P_{Rm} = \left(1 - \left(\frac{\lambda - \partial U/\partial V_{Rm}}{\lambda \eta_{Rm}}\right)\right)^{-1} \left(C_{Rm} + \frac{\partial q_{Rm}/\partial P_{Rm}}{\partial Q_{Rm}/\partial P_{Rm}}\left(a_m - C^{a}_{Rm}\right)\right) \tag{6}$$

$$P_{Bm} = \left(1 - \left(\frac{\lambda - \partial U/\partial V_{Bm}}{\lambda \eta_{Bm}}\right)\right)^{-1} \left(C_{Bm} + \frac{\partial q_{Bm}/\partial P_{Bm}}{\partial Q_{Bm}/\partial P_{Bm}}\left(a_m - C^{a}_{Bm}\right)\right) \tag{7}$$

$$a_m = \left(1 - \left(\frac{\lambda - \partial U/\partial V_{Rm}}{\lambda \eta^{a}_{Rm}}\right) - \left(\frac{\lambda - \partial U/\partial V_{Bm}}{\lambda \eta^{a}_{Bm}}\right)\right)^{-1} \times \left(\frac{\partial q^{a}_{Rm}/\partial a_m}{\partial q^{a}_{m}/\partial a_m} C^{a}_{Rm} + \frac{\partial q^{a}_{Bm}/\partial a_m}{\partial q^{a}_{i}/\partial a_m} C^{a}_{Bm} + \frac{\partial Q_{Rm}/\partial a_m}{\partial q^{a}_{m}/\partial a_m}\left(P_{Rm} - C_{Rm}\right) + \frac{\partial Q_{Bm}/\partial a_m}{\partial q^{a}_{m}/\partial a_m}\left(P_{Bm} - C_{Bm}\right)\right) \tag{8}$$

where η_{Rm} and η_{Bm} are own-price elasticities of demand for retail service, η^{a}_{m} is the own-price elasticity of demand for access to the incumbent's essential facility, $q^{a}_{m} = q^{a}_{Rm} + q^{a}_{Bm}$,

$\frac{\partial q^{a}_{Rm}/\partial a_m}{\partial q^{a}_{m}/\partial a_m}$ and $\frac{\partial q^{a}_{Bm}/\partial a_m}{\partial q^{a}_{m}/\partial a_m}$ are R and B's share of the total change in equilibrium demand of access, respectively, $\frac{\partial Q_{Rm}}{\partial a_m} = \frac{\partial Q_{Rm}}{\partial P_{Rm}}\frac{\partial P_{Rm}}{\partial a_m}$ and $\frac{\partial Q_{Bm}}{\partial a_m} = \frac{\partial Q_{Bm}}{\partial P_{Bm}}\frac{\partial P_{Bm}}{\partial a_m}$.

Prices in (6) through (8) are the product of marginal opportunity cost and a markup that reflects the inverse elasticity pricing rule. In the retail equations, marginal opportunity cost for the incumbent is the sum of the direct cost of providing retail service and the opportunity cost of foregone access profit. For instance, foregone access profit in the residential price equation is measured by $-\frac{\partial q_{Rm}/\partial P_{Rm}}{\partial Q_{Rm}/\partial P_{Rm}}\left(a_m - C^a_{Rm}\right)$. The term

$\frac{\partial q_{Rm}/\partial P_{Rm}}{\partial Q_{Rm}/\partial P_{Rm}}$ measures how demand for the fringe's retail service (and hence the fringe's demand for access) declines when the incumbent sells one additional unit of its retail service. Direct marginal cost in the access equation is the weighted sum of the direct costs of providing fringe access to the essential facility and the opportunity cost of foregone retail profits.[14] Foregone retail profits in the access price equation, $\frac{\partial Q_{Rm}/\partial a_m}{\partial q^a_m/\partial a_m}\left(P_{Rm} - C_{Rm}\right)$ and $\frac{\partial Q_{Bm}/\partial a_m}{\partial q^a_m/\partial a_m}\left(P_{Bm} - C_{Bm}\right)$, reflect the ECPR. The terms $\frac{\partial Q_{Rm}/\partial a_m}{\partial q^a_m/\partial a_m}$ and $\frac{\partial Q_{Bm}/\partial a_m}{\partial q^a_m/\partial a_m}$ are displacement ratios that measure the decline in retail sales for the incumbent when it provides the fringe with an additional unit of access to the essential facility (*See* Armstrong et al., 1996).[15]

All prices are marked above (below) cost with respect to the elasticity of demand for each service, the weight regulators place on incumbent's profits, and the political influence of different consumer groups and/or regions. When the political influence of consumer groups is relatively small so $\frac{\partial U}{\partial V_{Rm}}$ and $\frac{\partial U}{\partial V_{Bm}}$ are close to zero in (6) and (7), and corresponding displacement ratios are zero, retail price equations approach the monopoly markup. When $\frac{\partial U}{\partial V_{Rm}}$ and $\frac{\partial U}{\partial V_{Bm}}$ are relatively large and close to λ, retail

[14] Given two retail markets, $\frac{\partial q^a_{Rm}/\partial a_m}{\partial q^a_m/\partial a_m}C^a_{Rm} + \frac{\partial q^a_{Bm}/\partial a_m}{\partial q^a_m/\partial a_m}C^a_{Bm}$ leads to productive inefficiency when there is a single access price. This is because regulators must use the average direct cost of access when setting access prices even though the incumbent's cost of supplying access could differ across consumer groups.

[15] If the fringe output is a perfect substitute for the incumbent's retail offering, the term is equal to 1, if the two are complements, the term is -1 and if they are unrelated, the term would equal zero.

price equations approach direct marginal cost. Furthermore, when the political influence of group R raises the regulators' disutility of increasing P_{Rm}, group B's retail price may have to be raised to subsidize below-cost prices for group R to satisfy the incumbent's profit constraint. Ideally, the regulator should have two access prices available, for instance, a_{Rm} and a_{Bm} in *case (i)*. When group R exerts considerable political pressure the regulator would decrease a_{Rm} to encourage entry in market R but increase a_{Bm} to protect the cross-subsidy. However, in practice, regulators are often stuck with a single compromised access price, a_m, that rises or falls with the relative strength of influence for each group and the extent of cross subsidy.

III. Empirical Framework and Data

We test the implications of the theoretical model using data on RBOC local telephone prices in the U.S., including regulatory-determined prices competitors pay for access to RBOC networks. Large variations in regulatory and market conditions across and within states provide a unique opportunity to test the implications of the theoretical model outlined above.

An important implication of the theoretical framework is that political influence and price-cost margins for one particular customer group and/or region can affect prices for other groups and regions. This suggests that cost-based guidelines for access pricing are difficult to implement when they imply a re-balanced pricing structure significantly different from the status quo. Different customer groups and regions within a state that are required to pay higher prices under cost-based prices may use political pressure to prevent adverse price changes, even though these changes lead to greater efficiency.

Because of this, empirical research cannot consider states to be a single homogenous unit of observation because that would mask important intrastate relationships between prices.

Consider the case of k regions m = 2 customer groups, corresponding to residential and business. To obtain price equations suitable for estimation we approximate (6) through (8) with an exponential functional form and variables that measure cost, demand, political influence and the regulatory environment. Estimating equations for location i in region k are:

$$\ln P_{Ri} = \alpha_{Ri} + \beta_R C_{Ri} + \chi_R (a_i - C_i^a) + \boldsymbol{\gamma}'_{\mathbf{R}} \mathbf{y}_{\mathbf{R}i} + \boldsymbol{\kappa}'_{\mathbf{R}} \mathbf{z}_{\mathbf{R}i} + \boldsymbol{\varphi}'_{\mathbf{R}} \mathbf{x}_{\mathbf{R}i} + \varepsilon_{Ri} \qquad (9)$$

$$\ln P_{Bi} = \alpha_{Bi} + \beta_B C_{Bi} + \chi_B (a_i - C_i^a) + \boldsymbol{\gamma}'_{\mathbf{B}} \mathbf{y}_{\mathbf{B}i} + \boldsymbol{\kappa}'_{\mathbf{B}} \mathbf{z}_{\mathbf{B}i} + \boldsymbol{\varphi}'_{\mathbf{B}} \mathbf{x}_{\mathbf{B}i} + \varepsilon_{Bi} \qquad (10)$$

$$\ln a_i = \alpha_i^a + \beta^a C_i^a + \delta(P_{Ri} - C_{Ri}) + \phi(P_{Bi} - C_{Bi}) + \boldsymbol{\gamma}^{\mathbf{a}'} \mathbf{y}_i^{\mathbf{a}} + \boldsymbol{\kappa}^{\mathbf{a}'} \mathbf{z}_i^a + \boldsymbol{\varphi}^{\mathbf{a}'} \mathbf{x}_i^{\mathbf{a}} + \varepsilon_i^a \qquad (11)$$

where P_R is the monthly price for residential service, C_R is the direct marginal cost of providing residential service, a is the monthly price for purchasing access to the incumbent's essential facility, C^a is the direct marginal cost of providing access, **y** is a vector of political influence variables, **z** is a vector of regulatory environment variables, **x** is a vector of demand variables, P_B is the monthly price for business service, C_B is the direct marginal cost of providing business service, the α's are fixed-effect parameters, β is a direct marginal cost parameter, χ is an foregone access profit parameter, δ and ϕ are foregone retail profit parameters, **γ** is a vector of political influence parameters, **κ** is a vector of regulatory parameters, **φ** is a vector of demand parameters and ε is an error.

Below, we estimate (9) through (11) with data for U.S. local telephone markets. Our approach differs from Kaserman et al. (1990), Eriksson et al. (1998), Abel (2002), de Figueiredo, Jr. and Edwards (2004) and Knittle (2004) who use more aggregated data to examine these markets. Here, we estimate retail and access prices, but use intrastate data to control for the relationship between retail prices for different services, both within and between regions, as implied by theory.

A. Data

To estimate the empirical model, we gathered data on retail and access services for the original RBOCs at July 1, 2002 for 7,661 wire centers in 43 states.[16] Focusing on RBOC data is useful because state regulators' decisions generally require that a firm be continually viable so the regulator considers all of the firm's operations in the state. This paper does not address pricing decisions for small rural telephone companies, in part because such companies were not generally subject to the same market opening and unbundling requirements as the RBOCs.

Since most states have three UNE zones, generally representing *urban*, *suburban* and *rural* regions, we use that convention to define $k = 3$ regional markets in each state. Urban UNE regions consist of wire centers with the lowest UNE prices in a state and rural regions include wire centers with the highest UNE prices. Remaining wire centers are suburban.[17] We limit the empirical analysis to urban and rural regions. Estimation on these regions provides the starkest contrast with respect to population density, political influence and implicit cross-subsidy.[18]

There are large UNE price differences both within and between states. For example, in New York, the lowest-price UNE zone includes densely populated areas, with a teledensity of more than 100,000 telephone lines per square mile. However, the teledensity in North Dakota's most urban zone is only 300 lines per square mile.

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[16] Alaska, Connecticut and Hawaii are excluded because they were not served by the original BOCs. Wyoming and Montana are excluded because prices differ within wire centers based on distance from the switch. Idaho and Delaware are excluded because of insufficient cost data, and DC is excluded because it has only one UNE zone.
[17] Chow tests reject the null hypothesis that the data-generating processes are the same across regions.
[18] Results for suburban region regressions are available from the authors upon request.

Teledensity is much lower in rural zones than urban zones within the same state; approximately 5 lines per square mile in North Dakota and 204 lines per square mile in New York. Low cost areas in rural states would be relatively high cost in more urban states. UNE loop prices reflect these differences. In New York, the urban UNE loop price is $7.70, while the urban UNE loop price is nearly twice as high, $14.78, in North Dakota. In rural areas, the difference is more pronounced; $15.51 in New York and $56.44 in North Dakota. These data suggest that regulators in different states face different optimization problems, and taking statewide averages can mask substantial intrastate variation.

B. Sample Characteristics

Table 1 provides selected regional characteristics, prices and costs for 7,661 wire centers. 1,345 wire centers are urban, 2,104 are suburban and 4,212 are rural. Rural wire centers tend to include substantially more area than urban wire centers, but serve fewer customers. The average rural wire center covers over 137 square miles, providing service to over 6,000 lines, while the average urban wire center covers approximately 55 square miles and contains over 36,000 lines. The average urban wire center has over 4,800 lines per square mile, while rural wire centers average only 137 lines per square mile.

Table 2 shows access prices are closely related to estimates of marginal cost.[19] In fact, access prices are below estimated marginal cost in urban regions, about equal to estimated marginal cost in suburban regions, and above estimated marginal cost in rural regions. Table 3 indicates business retail prices exceed estimated marginal cost in most

[19] Marginal cost is estimated using data from the FCC's Hybrid cost proxy model. UNE price is the sum of the rental price for the loop and the rental price for switch port (i.e., the interface between the switch and the loop). Flat-rated retail prices are used, when available.

wire centers. By contrast, Table 4 shows that less than 14 percent of lines have residential prices that exceed estimated marginal cost. A comparison of average retail business and residential prices and estimated marginal costs shows that the average retail business price is about 90% higher than the average residential price ($35.65 versus $18.77), while the estimated marginal cost for business service is 34% lower than the estimated marginal cost of residential service ($15.23 versus $23.10). Estimated price-cost margins suggest that incumbents earn the largest profit from business customers in urban and suburban zones, while residential customers in rural zones are the least profitable. These data are generally consistent with the notion that business customers subsidize residential customers and that urban regions subsidize rural regions.[20] The mark-up of retail over UNE prices follows the same pattern as price-cost margins. In all zones, retail business prices are at least $15 greater than the new entrant's monthly cost of leasing a loop and a port, with the largest margin, $23.06, found in urban zones.[21] Overall, nearly every retail business price exceeds the UNE price (i.e., the cost of leasing a loop and port). These data suggest that new entrants are less likely to target residential customers. The retail-UNE margin for residential customers is largest in the urban zone, $5.14, while the average margin is negative in rural zones.

C. Variable Descriptions

Dependent Variables: Retail prices were obtained from RBOC and state PUC websites. Retail prices for business and residential service are the sum of the state-determined monthly charge for local service, federal subscriber line charge, primary inter-exchange

[20] While price-cost margins are consistent with the presence of cross subsidy, prices in this paper only include revenues from basic local service and omit other revenues such as call waiting, etc.

[21] The UNE price differs in the three tables because of the use of lines for weighting – business lines in the business table, residential lines in the residential table, and all lines for the UNE table.

carrier charge, and state charges for non-optional extended areas of service.[22] Access prices were obtained from Gregg (2002), and were cross checked and supplemented with data from the applicable RBOC state-tariff filings and PUC web sites. The access price is the sum of the UNE price for the loop and the rental price for the switch port (i.e., the interface between the switch and the loop). Telcordia (2000) data were used to match the retail and UNE prices with the appropriate wire center.

Intra-Region Price-Cost Margins: Theory and empirical evidence suggest that regulators trade off residential and business prices according to political influence. To account for the political strength of different groups within a regional market, our initial specification of the residential (business) price equation includes the business (residential) price-cost margin, *BPCM* (*RPCM*), for the same wire center. These variables are equal to the difference between prices and estimated marginal cost of retail service provision in a wire center. The finding that increases in *BPCM* (*RPCM*) lower residential (business) prices supports the prediction that political influence matters, and is consistent with implicit cross subsidy between residential and business customers within the same wire center.

The FCC (1996) explicitly rejected the ECPR methodology that considers foregone profits in the setting of access prices because it would not provide a mechanism to force retail prices to competitive levels. However, theory indicates that political factors and foregone profits require regulators take into account the price-cost margins of other services when setting retail and access prices. We, therefore, include the access

[22] Prices are for flat-rated service, which allows unlimited calling within the customer's local calling area. In cases where states require measured service, where subscribers pay a monthly fee plus usage charges, estimates of monthly usage charges are included in the retail price. Retail price equations below include *RESMEAS (BUSMEAS)*, which equals one when residential (business) customers are required to purchase measured service, and zero otherwise, to control for the effect of measured service on demand and pricing

price-cost margin (*APCM)* in both retail price equations, and both *RPCM* and *BPCM* in the access price equation. *ACPM* is the difference between price and the estimated marginal cost of providing network access in the wire center. Positive coefficients for any of these price-cost margins are consistent with regulators considering lost revenue when setting service prices.

Inter-Region Price-Cost Margins: The theoretical discussion implies that political influence forces regulators to trade off prices in urban and rural regions of a state. Past research, common belief in the industry, and the summary statistics discussed above suggest that subsidies flow from business and urban customers to residential and rural customers. To capture this aspect of rate setting, we estimate price-equations that include *RUR RPCM*, the average residential price-cost margin in a state's rural regions, as an additional regressor in urban equations. Similarly, the urban business price-cost margin (*URB BPCM*) is also included as an additional regressor in rural price equations. An inverse relationship between *RUR RPCM* (*URB BPCM*) and urban (rural) prices is consistent with regulators accounting for inter-regional trade offs when setting prices.

Costs: The direct marginal cost of providing service in each wire center is estimated using data from the FCC's (2000) Hybrid Cost Proxy Model (HCPM).[23] In its implementation of the Telecom Act, the FCC (1996) required access prices be based on the TELRIC of elements,[24] and that each state establish at least three cost-based UNE zones. However, because forward-looking cost estimates are a function of many inputs,

[23] The HCPM is based on engineering estimates of forward-looking economic costs assuming current wire center locations. These costs estimates are not the same as the historical or embedded costs that were incurred to build the network. Because we use cross-section estimation, the level of the cost is not as important as the relative costs across regions, and some of the criticisms of the HCPM should not affect our results. See Appendix for more detail on the marginal cost estimates obtained for this study.
[24] The TELRIC standard is consistent with the notion of economic cost plus a reasonable mark-up for joint and common costs. See Farrell (1996) and Noll and Rosston (2002) for additional discussion.

such as cost of capital, depreciation rates, cost of labor, and fill factors, state regulators have a great deal of flexibility in setting access prices and the relationship between access costs and prices is not clear.[25] A positive association between the cost of providing network access and the access price indicates that state regulators are complying with the cost-based access pricing rule. Similarly, positive relationships in retail price equations suggest regulators' retail pricing guidelines are cost based.

Theory suggests that when setting prices in a particular locality regulators are concerned about costs across the entire state. This is particularly acute in rural states where the cost of providing subsidies to rural constituents increases with the percentage of rural lines in the state (*RURAL POP*).[26] The prediction is that regulators "share the pain" from higher costs by raising prices for members and non-members of the subsidized, rural group. To examine this possibility, we include *RURAL POP* in all retail price equations for all regions.

Federal USF: Because of the large differences in cost conditions across states, the FCC and state PUCs oversee a federal Universal Service Fund (USF), the intent of which is to keep prices affordable in high-cost areas. Telecommunications companies contribute a percentage of their interstate revenues to the Universal Service Administration Company (USAC), which distributes subsidies to companies providing service to targeted wire centers. In implementing the Telecom Act, the FCC provided direct support to high-cost wire centers, and allowed new entrants to receive federal

[25] *See* Nuechterlein and Weiser (2005) p-84 and Gifford (2003) for further discussion of the leeway given to state regulators.
[26] *RURAL POP* is approximated by the percentage of households located in rural areas, as defined by the census, in the area served by the incumbent in a state.

subsidies if they serve customers in these wire centers.[27] As part of its USF support mechanism for large carriers, the FCC requires that states receiving federal support must certify that rural rates within their boundaries are reasonably comparable with urban rates, or funds may be withheld.[28]

To investigate the effect the federal universal service program has on local prices, we construct *USF*, the monthly per-line federal subsidy targeted to a wire center in the second quarter 2002. Because only five urban wire centers attract high-cost support, and the support is small (averaging $0.86 per subsidized line), we only include *USF* in rural retail price equations where 512 wire centers are subsidized.[29] Our theoretical discussion raises the possibility that rural USF support may be used to lower urban retail prices as well, and we include *RURAL USF* (average per-line subsidy in a state's rural zone) in both urban retail price equations. *USF* may also affect access prices.

Armstrong and Sappington (2004) argue that it is generally not optimal for regulators to set access prices at cost when retail prices are distorted and there are no

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[27] Support is provided to large phone companies (in FCC parlance, the non-rural companies) in states where HCPM-estimated state-average cost is greater than 135 percent of the national average cost for large carriers. Federal non-rural USF support is distributed to Alabama, Kentucky, Maine, Mississippi, Vermont and West Virginia. Montana and Wyoming also receive support, but are not included in our data. Total non-rural federal universal support in 2002 was $840 million. For the second quarter 2005, telecommunications companies paid 11.1 percent of the interstate revenues into the USF. Most companies charge a universal service fee to their customers to recover their contribution to the USF. USAC estimates that total USF collections for this quarter are about $1,806 million, of which $1,015 million goes to high-cost support (about $207 million goes to low-income support, $577 million to schools and libraries, and $6 million to rural health care). There are also extensive transaction costs incurred by the FCC to calculate fund contributions and to identify high-cost areas.

[28] See United States Court of Appeals, 10th Circuit, Qwest v. FCC, No. 03-9617, Feb 23, 2005. In this ruling the 10th Circuit upholds the mechanism the FCC adopted to induce states "to assist in implementing the goals of universal service. (pp. 31-2)" However, in this decision, the 10th Circuit required that the FCC revisit several issues related with its non-rural USF program, including the manner in which USF support is distributed to states.

[29] Data on subsidies distributed by the high-cost program of the federal USF were obtained from the USAC. The federal USF provides support to 677 of the 7,661 wire centers in our data: five are urban; 160 are suburban; and 512 are rural.

other tax instruments available to the regulator. A negative association between *USF* and access prices would lend support to this conjecture.

271 Approval: Hausman et al. (2002) find that new entrants had a larger market share in states with 271 approval. FCC (2002) data indicate that at June 30, 2002, new entrants provided 11.4 percent (22 million) of the 189 million local telephone lines in the U.S, and a least one new entrant was in 67 percent of U.S. zip codes.[30]

We include *S271* (equals one if the RBOC received Section 271 approval by July 1, 2002 in a state and zero otherwise) in all equations to capture the impact the removal of local entry barriers and incumbent line-of-business restrictions have on prices.[31] If business services have historically subsidized residential services, increased entry and competition may result in lower business prices and higher residential prices. Removal of line-of-business restrictions loosens the incumbent's profit constraint, which may allow regulators to decrease all prices, including access prices.

Political Influence: The relative size of different constituencies may be used to proxy the political power of different groups. To capture this aspect of the data, we include *POP-EMP*, which is the ratio of residential population to number of service employees in a region, to measure the relative importance of residential to business customers. An increase in a group's political influence should reduce (increase) prices paid by members (non-members) of that group. However, as noted above, an increase in

[30] Just over half of these lines were used to serve residential and small-business customers. Entrants provide 21 percent of their lines by reselling, 50 percent are unbundled network elements and the remainder are provided through the entrants' own facilities.

[31] The Department of Justice (DoJ), in an affidavit filed by Schwartz (1997), adopted an "Open Local Market" standard for authorizing RBOC entry into long-distance markets. The standard requires that the local market in applicant RBOC's state is "fully and irreversibly open to competition through all three entry modes envisioned by the Telecommunications Act – facilities based, resale and unbundled elements."

a subsidized group's size increases the cost of providing subsidies, which may result in higher prices for both members and non-members of the subsidized group.

Regulatory Environment: To estimate the effect the above variables have on prices, it is also important to consider the characteristics of regulators and local politicians, along with the states' regulatory regime.

New entrants and incumbents have vested interests in the result of PUC proceedings that affect access prices, and may attempt to influence outcomes by contributing to state politicians. To capture the potential impact political contributions have on access prices, we include *CONTRIB*, which equals the ratio of dollars contributed to state politicians by donors affiliated with competitors to contributions made by donors affiliated with the RBOC in the state for the 2000 election cycle.[32]

We include *REP GOV* (which equals one when the state's governor is a Republican and zero otherwise), *REP PUC* (equals one when the majority of state's PUC commissioners are Republican and zero otherwise), *ELECT* (equals one when PUC commissioners are elected by the general population and zero otherwise) and *PRICECAP* (equals one if the PUC used price caps to regulate local prices in 2000 and zero otherwise) in all price equations to control for the regulatory environment within a state.[33]

Demand: To control for demand in the residential price equation, we include the percentage of a wire-center's population over 60 years of age (*AGE*), the percentage of white households (*WHITE*), and is the percentage of residents under the poverty level

[32] Data are obtained from The Institute on Money in State Politics at www.followthemoney.org. Non-incumbent RBOC wireless carriers are included as competitors. We divided the contributions between RBOC, CLEC and others and were able to categorize more than 99 percent of contributions.
[33] Data were obtained from the National Association of Regulatory Utility Commissioners (2002), National Center for Appropriate Technology (2005), U.S. Census Bureau (2002) and from David Sappington.

(*POVERTY*). We also include *LCA*, which is the number of households in the customer's free local calling area. In the business equations we include, the number of employees in the wire center (*EMPLOY*), the percentage of service employees (*SERVICE)*, and the percentage of establishments with less than 20 employees (*SMALL FIRMS*).[34] *EMPLOY* and *LCA* are included in the access-price equation. Additionally, we include the percentage of a state's lines in the appropriate region (*PTLINES*) in the access-price equation, to capture the importance of access prices on the incumbent's budget constraint.[35] Regulators may have the incentive to set higher access prices the larger the share of lines represented by a region.

IV. Estimation

Theory and practice suggests state regulators consider all retail and access prices when setting prices, so any price-cost margin used as an explanatory variable is endogenous. *S271* is also likely endogenous because state regulators (in consultation with the FCC and the DoJ) evaluate incumbent's 271 applications and also make decisions about prices. Both decisions may be correlated with unobserved factors. While Hausman (1978) statistics provide mixed results concerning the endogeneity of *S271* in price equations, we proceed cautiously and treat *S271* endogenous. *PRICECAP* is endogenous when prices at time *t* affect the choice of regulatory mechanism at time *t*. This is unlikely in telecom markets where the regulator takes time to implement changes such as the introduction or removal of price caps. Furthermore, since *PRICECAP* is constructed from 2000 data, we treat it exogenous.

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[34] *SMALL FIRMS* is appropriate since small firms are less likely to bypass the incumbent's network with private networks, and are the primary customers of business service we examine in this study.

[35] Demographic data for each wire center were obtained by matching census block group data from the 2000 decennial census to wire centers using Claritas (2003). The data also include information on business conditions, obtained from the Census's 2000 County Business Patterns, for the county in which the majority of a wire center is located.

Initial price equations contain three endogenous variables: the two remaining intra-wire center price-cost margins and *S271*. Two-stage least squares (2SLS) estimates of these equations are obtained by using all exogenous variables as instruments, along with *DEREG* (equals one if the state deregulated its electric power industry before 2002, and zero otherwise) and *S271_01* (equals one if the RBOC's 271 application was approved by June 2001 and zero otherwise).

Subsequent price equations are augmented with an inter-region price-cost margin, which is also endogenous. Here, 2SLS estimates are obtained by using all exogenous variables as instruments, along with *DEREG*, *S271_01* and several additional variables that reflect fundamental cost and demand conditions in the other regions of the state. When the inter-zone price is the average rural resident price-cost margin (*RUR RPCM*), we employ average values for *DENSITY* (number of lines per square mile), *PTLINES* (percentage of total lines in the state from that non-urban regions), *POP-EMP*, *LCA*, *USF*, *EMPLOY*, *POVERTY*, *WHITE* and *AGE* in rural regions as additional variables. When the inter-zone price is the average urban business price-cost margin (*URB BPCM*), we employ average values for *PTLINES*, *DENSITY*, *SERVICE, POP-EMP, EMP,* and *LCA* in the urban regions of the state as additional variables.

Pagan-Hall test statistics from 2SLS results indicate that heteroskedasticity is present throughout all price equations. As such, Generalized Method of Moments (GMM) is used to obtain robust estimates with heteroskedasticity of unknown form. Because state regulators set prices throughout the state, observations on wire centers drawn from the same state are likely to be correlated, while observations on wire centers in different states are not. Following Baum (2003), we use weighting matrices that allow for intra-state clustering among wire centers.

A. Results

Tables 5 and 6 provide residential, business and access price-equation estimates for rural and urban regions, respectively.[36] For purpose of comparison, we present estimates from two alternative model specifications. The first set of estimates reported in each table includes intra-region price-cost margins from competing customer groups within the wire center as regressors. The second set of estimates adds inter-region variables as additional regressors: the rural residential price-cost margin and rural USF subsidies for urban equations; and the urban business price-cost margin for rural equations.

Intra-Region Price-Cost Margins: Estimates of urban retail price equations, suggest regulators trade off business and residential prices within the wire center. In the urban residential price-equation, column one of Table 5, the estimated coefficient on the intra-region price-cost margin (*BPCM*) is -0.004 and highly significant. A dollar increase in the urban business price-cost margin decreases residential prices by 0.4%. Given an average residential price of $18.51, this implies a seven and a half cent decline in the residential price. In effect, higher price-cost margins for urban-business consumers permit regulators to lower prices for urban-residential consumers and still satisfy the incumbent's profit constraint.

Model results provide some evidence that regulators price take into account revenue effects from mandating access. In both urban retail price equations (columns 1 and 3 of Table 5), estimated coefficients on the access price-cost margin are positive. In

[36] Intercepts vary across regions served by different incumbents. Partial R^2 statistics by Bound et al. (1995) and Shea (1997) suggest good explanatory power of excluded instruments in first-stage regressions. Hansen (1982) J statistics do not reject the null of zero correlation between instruments and errors.

the rural business price equation (column 3 of Table 6), the coefficient on the access price-cost margin is also positive. These results are robust to the inclusion of inter-region price-cost margins. Similar evidence is obtained from the urban access price equation (column 5 of Table 5), with the access price-cost margin positively associated with business and residential prices, respectively. While it appears that state regulators behave contrary to FCC (1996) policy when setting access prices (by accounting for the impact lost profit opportunities have on the incumbent), the estimated effect is small. For instance, results indicate that a one dollar increase in the urban business (residential) price-cost margin increases UNE prices by 0.7% (1.0%). With an average UNE price of $12.77, this would be lead to a nine (thirteen) cent change in the UNE price.

When inter-region variables are considered in the model specification, evidence of a business-residential trade off within urban regions is weaker. Estimates of the urban-residential price equation, reported in the second column of Table 5, show the coefficient on the intra-region price-cost margin (*BPCM*) has decreased to -0.001 and is not significant. The relatively large negative coefficient on (*BPCM*) in the first estimate, implying an intra-region trade off, is likely attributed to model misspecification and particularly, omission of the rural residential price-cost margin (*RUR RPCM*).[37] Aggregated studies that rely on state-average prices, or ignore rural areas, do not properly capture the political process followed by regulators, and potentially misinterpret the nature of the trade offs they face.

[37] The relationship between urban and rural residential prices is expected to be positive, and the relationship between urban business and rural residential prices is expected to be negative. Thus, the bias will be negative and could change a positive or small negative coefficient on *BPCM* into a large negative coefficient.

Inter-Region Price-Cost Margins: Consistent with our theoretical model, estimation results discussed above indicate that several inter-region variables affect the price setting behavior of regulators. It is apparent that regulators decide on an overall price structure for the state when setting prices for each locality, and the omission of inter-region variables adversely affects several of the estimated coefficients of interest. Accordingly, the discussion below focuses primarily on price-equation estimates with inter-region variables, found in columns two, four, and six of Table 5.

The rural residential price-cost margin (*RUR RPCM*) is positively related to urban residential prices, and the urban business price-cost margin (*URB BPCM*) is positively related to rural business prices. These findings suggest regulators tend to set all residential (or, business) prices similarly rather than trade off urban to rural regions within a specific class of customer service. The negative relationship between the rural residential price-cost margin and urban business prices is consistent with urban to rural cross subsidization across customer services. A dollar increase in the rural residential price-cost margin decreases urban business prices by 1.5%. Given an average business price of $35.83, this implies a fifty-two cent decline in the urban business price. Overall, there are about 0.95 rural residential lines for each urban business line, so that means that slightly more than half of the increase in revenues would be used to offset urban business prices. For the rural residential price, the change in price from an increase in the urban business price cost margin is one percent, or seventeen cents. This is less than half of the dollars from the change, but some would also go to suburban residential customers. The negative relationship between the urban business price-cost margin and rural residential prices provides additional support for this finding.

Costs: In both urban and rural regions, the estimated (direct) marginal cost of providing service has a positive effect on the residential price, but no effect on business prices. In some sense this is consistent with a trade off between urban residential and business customers. Regulators are more responsive to changes in the cost of providing residential service, and pass on cost reductions directly to residential consumers. In both urban and rural regions, marginal cost is not related to access prices. *Prima facie*, this suggests state regulators are not complying with the FCC (1996) order that they set access prices based on the direct cost of providing service. However, the evidence is not overwhelming and is sensitive to different measures of direct cost. When we employ the average marginal cost of providing network access for the region (UNE zone) in which the wire center is located, we find a significant positive correlation with access prices.

When setting urban prices, regulators are concerned with costs across the entire state. An increase in *RURAL POP* indicates a higher overall cost of providing service in the state and a need for more subsidy dollars to support these areas. Consistent with the "share the pain" theory, regulators spread higher costs by raising prices for all consumer groups and regions in the state. Accordingly, the estimated coefficient on *RURAL POP* is positive in the urban-residential, urban-business, rural-residential and rural-business price equations. The magnitudes of the coefficients are similar as well which means that the effect of a cost increase is shared equally across the state.

Federal USF: We find no evidence that federal USF subsidies lower retail prices in targeted, high-cost wire centers.[38] Wire-center-specific USF (*USF*) is insignificant in

[38] Eriksson et al. (1998) and Ackerberg et al. (2005) discuss targeted subsidy schemes in the context of low-income support and find that those do have an effect.

both the residential and business price equations in rural regions.[39] This finding should concern consumer groups, tax payers and the FCC, where substantial resources are used to identify high-cost wire centers and justify the support to keep rural prices low. By contrast, the estimated negative coefficient on *RURAL USF* in the urban business price equation indicates that an increase in the federal universal service fund is associated with lower urban business prices. This is consistent with the urban-rural trade off described above. The magnitude of the coefficient is similar to the *RUR RPCM* coefficient (0.013 vs. 0.015). As discussed above, this means that a dollar in additional targeted federal universal service funding would reduce urban business prices by forty seven cents. The similarity in magnitude indicates that regulators view the contribution of an additional dollar from different sources similarly and use it to reduce the burden on higher business prices. This finding helps explain the insignificant coefficient on targeted USF payments (*USF*) in the rural retail price equations in Table 6. It also helps to explain the finding by Kaserman et. al. (1990) that explicit subsidy dollars do not lower residential prices. Instead of providing price relief for rural customers, regulators transfer the money back to urban businesses, which had been the source of subsidy money.[40]

Interestingly, the estimated coefficient on *USF* is negative in the rural access price equation. This result provides empirical support for Armstrong and Sappington's (2004) conjecture that it is generally not optimal to set access prices at cost when retail prices are distorted and a taxing instrument is unavailable to the regulator.

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[39] In other specifications, not reported, *USF* and average urban USF were included in the urban and rural price equations, respectively, were insignificant and had no appreciable impact on the other coefficients.

[40] Our analysis focuses on RBOCs, which have substantial urban and rural service territories. State regulators may not be able to effectuate such transfers within smaller rural telephone companies that do not serve urban business customers. It is possible that USF subsidies may affect local telephone penetration through non-price channels, such as quality improvements.

An additional factor that state regulators control is the designation of competitors as "Eligible Telecommunications Providers" ("ETCs") that can compete with incumbent providers for explicit universal service subsidy funds. The effect of these has been small for a couple of reasons: there are few competitors that have been approved as ETCs; ETCs serve a small number of lines; and ETCs cannot access the implicit subsidy dollars.

Section 271 Approval: In contrast to Hausman et al. (2002), we find that urban-residential prices are higher and urban-business prices lower in states where the incumbent has been granted 271 approval. The change in relative prices is substantial. The urban business price is 20 percent lower in states with 271 approval and residential prices are almost six percent higher. Some of the change may be due to rebalancing of prices in the face of competition.[41] In addition, it appears the regulators take advantage of the additional revenue stream to reduce prices overall. There are about 1.4 urban residential lines for each urban business line so that a 20 percent reduction in business prices outweighs the six percent increase in residential lines, so rebalancing is not the only effect of 271 approval. Because many states also required unbundled network element platforms (UNE-P) at the time of 271 approval, it might be surprising that urban residential rates increased instead of decreasing. However, the low prices for residential service even in urban areas (see Table 4) and the small amount of entry by CLECs targeting residential customers (Greenstein and Mazzeo (2004)) explains why urban residential prices increased with 271 approval. The finding of no impact in rural regions is consistent with the widely held belief that competition is concentrated in urban areas.

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[41] Knittle (2004) shows that increased local competition in seventy cities from 1988 to 1995 resulted in a 2.5 percent decrease in business prices and a 3.6 percent increase in residential prices.

Results also indicate that 271 approval leads to substantially lower access prices in rural areas.[42]

Political Influence: The relative importance of residential customers compared to business customers (*POP-EMP*), and the percentage of households located in rural areas (*RURAL POP*), are important determinants of retail prices. Urban and rural regions with more residential relative to business customers have higher business prices. This suggests that the influence of residential customers can lead to business customers bearing a greater cost burden. Additional evidence supporting this conclusion is obtained from estimates of access-price equations. Urban access prices are higher in areas with a large share of residential customers. Higher access prices are an entry barrier that potentially restricts competition in lucrative business markets, permitting regulators to maintain the status quo in terms of cost incidence. The positive coefficient on *RURAL POP* in urban retail price equations could also have a political influence power interpretation. However, this is unlikely given *RURAL POP* is also positively related to rural retail prices.

Regulatory environment: Although not the main focus of this study, some discussion of the relationship between regulatory environment variables and prices is warranted. The interpretation of the negative coefficient on political contributions (*CONTRIB*) is clear. Increased contributions by the incumbent relative to new and potential entrants increases the access price in lucrative urban regions. A one percentage point change in the ratio of contributions by incumbents relative to new entrants increases

[42] As July 1, 2002, the FCC had approved 271 applications in Arkansas, Connecticut, Georgia, Kansas, Louisiana, Massachusetts, Maine, Missouri, New Jersey, New York, Oklahoma, Pennsylvania, Rhode Island, Texas and Vermont. The FCC was in the process of reviewing applications from Alabama, Kentucky, Mississippi, North Carolina, South Carolina, New Hampshire and Delaware. Results where we include a variable for 271 applications under review yields largely similar results to those above.

the urban access price by 0.8 percent. With the average urban access price of $13.12, the change would be eleven cents.

Regulatory and political variables are also important. Republican governors and Republican PUCs have different effects – Republican governors tend to reduce the urban retail prices and Republican PUCs increase all retail (urban and rural) prices. In contrast, Republican governors have no impact on UNE prices and Republican PUCs lead to lower urban UNE prices. The Republican PUC effect may come from more cost-based retail prices and less pressure to set above cost UNE prices simply to protect sources of implicit subsidy. The election of PUC Commissioners leads to higher retail and access prices. This may be due to the political influence of the incumbents in the election process.

Finally, states with price caps in place in 2000 tend to have significantly higher urban residential and business prices in 2002. Price caps give the regulated firm more flexibility and tend to be in place for a period of several years so that the firm may have less pressure to reduce the monthly prices. Instead, it may focus on reducing other prices, like long-distance access charges, that would otherwise expose the incumbent to more intense competition for the most valuable customers. The added flexibility provided by price caps allows regulators to set lower access prices.[43]

V. Conclusions

The United States regulatory system requires coordination between federal and state bodies. Typically, federal rules are set with significant discretion for state implementation. Because state regulators have different preferences, costs, and constituencies, they do not implement policy in the same way. As a result, federal

[43] See Abel (2002) and de Figueiredo, Jr and Edwards (2004) for political explanations for these results.

policymakers need to understand these pressures to understand the ramifications of their decisions.

Assessment of the effectiveness of federal policies, rules and regulations requires understanding of the tensions and trade offs facing state regulators. The empirical challenge for applied economists is the specification of models that consider these trade offs explicitly, and the collection of sufficiently disaggregated data to identify how policies affect the appropriate intra-state constituents. This study employs a unique disaggregated data set for U.S. local telephone markets to examine empirically differences in state and intrastate characteristics that identify regulators' pricing behavior. We control for the interactions across all regions within a state and political influence to estimate the effect of federal rules and state implementation.

Our empirical analysis confirms that state regulators consider the relative political power of different consumers, incumbents and new entrants when they make retail and access price decisions. We find that state regulators consider the direct and opportunity cost of service provision when setting prices, but only use ECPR principles to a small extent. Regulators follow a "share the pain" method of dealing with higher costs in the state by increasing all prices across the state. In addition, targeted federal universal service subsidies do not lead to lower prices in the specific rural wire centers to which they are targeted. Instead state regulators appear to use the money to reduce urban business prices. State regulators have rebalanced prices towards more sustainable cost based rates in response to the introduction of additional competition. State regulators also have used the additional long distance revenue to reduce local rates.

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Table 1
Selected Summary Statistics
(standard deviations in parentheses)

Region characteristics	All Zones	Urban Zones	Suburban Zones	Rural Zones
Geographical area (mile^2)	107.27	55.57	80.64	137.08
	(166.63)	(89.29)	(103.06)	(201.40)
Telephone Lines per mile^2	1,310	4,804	1,426	137.5
	(9,628)	(22,290)	(3,038)	(397.2)
Households in local calling area (100,000's)	1.75	4.39	2.22	0.67
	(2.81)	(3.83)	(2.87)	(1.45)
Percentage of households in poverty	0.12	0.13	0.11	0.12
	(0.08)	(0.08)	(0.08)	(0.07)
Total employment (100,000's)	2.22	5.45	2.80	0.90
	(4.95)	(7.99)	(4.52)	(2.96)
% of establishments with < 20 employees	0.87	0.85	0.86	0.88
	(0.03)	(0.02)	(0.03)	(0.03)
Total lines at 2000	16,677	36,665	24,487	6,393
	(22,904)	(29,240)	(24,644)	(10,687)
USF contribution ($) per line (2nd Quarter 2002)	0.81	0.003	0.46	1.24
	(4.46)	(0.10)	(2.56)	(5.70)
Section 271 approval	0.41	0.32	0.46	0.42
	(0.49)	(0.47)	(0.50)	(0.49)
Number of observations	7,661	1,345	2,104	4,212

Table 2.
Summary of UNE Price, Costs and Lines 2002
(standard deviations in parentheses)

UNE Loop & Port	All Zones	Urban Zone	Suburban Zone	Rural Zone
UNE Price	15.77	13.12	15.65	20.86
	(5.72)	(3.13)	(4.13)	(8.11)
Estimated Marginal Cost	15.92	15.06	15.90	17.53
	(2.14)	(2.12)	(1.76)	(1.88)
Estimated Average Cost	20.18	17.51	19.12	27.08
	(8.62)	(3.66)	(5.05)	(14.71)
UNE Price- Marginal Cost	-0.15	-1.94	-0.25	3.33
	(4.93)	(2.98)	(3.68)	(7.43)
% Lines UNE Price>MC	40.29%	21.81%	43.32%	68.32%
Percentage of Lines (total)	100%	39.54%	38.99%	21.46%

Note. Summary statistics weighted by appropriate number of lines.

Table 3.
Summary of Business Price, Costs and Lines 2002
(standard deviations in parentheses)

Business Lines	All Zones	Urban Zones	Suburban Zones	Rural Zones
Retail Price	35.65	35.83	35.70	35.06
	(8.88)	(10.04)	(8.11)	(6.96)
Estimated Marginal Cost	15.23	15.10	15.29	15.46
	(2.02)	(1.81)	(1.89)	(2.71)
Retail Price – Marginal Cost	20.42	20.73	20.41	19.59
	(9.03)	(10.25)	(8.06)	(7.38)
UNE Price (Loop & Port)	14.89	12.77	15.31	19.66
	(4.77)	(3.03)	(3.69)	(6.65)
Retail Price - UNE Price (Loop & Port)	20.76	23.06	20.39	15.40
	(8.46)	(8.48)	(7.40)	(8.07)
Estimated Average Cost	19.90	18.09	19.85	24.86
	(5.53)	(3.27)	(4.17)	(8.95)
% Lines Retail Price >Marginal Cost	99.94%	100%	100%	99.65%
% Lines $P_{Retail} > P_{UNE\ (Loop\ \&\ Port)}$	99.79%	100%	99.92%	98.93%
Percentage of Lines	100%	46.44%	37.25%	16.3%

Note. Summary statistics weighted by appropriate number of lines.

Table 4.
Summary of Residential Price, Costs and Lines 2002
(standard deviations in parentheses)

Residential	All Zones	Urban Zone	Suburban Zone	Rural Zone
Retail Price	18.77	18.51	19.01	18.70
	(3.39)	(3.00)	(3.61)	(3.48)
Estimated Marginal Cost	23.10	22.45	22.61	24.93
	(2.75)	(2.07)	(2.49)	(3.22)
Retail Price – Marginal Cost	-4.33	-3.94	-3.59	-6.23
	(4.40)	(3.24)	(4.60)	(4.95)
UNE Price Loop & Port	16.25	13.37	15.81	21.33
	(6.12)	(3.18)	(4.31)	(8.57)
Retail Price – UNE Price (Loop & Port)	2.51	5.14	3.20	-2.63
	(6.49)	(3.03)	(5.25)	(8.93)
Estimated Average Cost	23.00	19.75	21.10	31.23
	(11.33)	(4.19)	(6.07)	(19.15)
% Lines Retail Price > Marginal Cost	13.58%	10.09%	18.95%	7.73%
% Lines $P_{Retail} > P_{UNE\ (Loop\ \&\ Port)}$	75.79%	93.92%	74.06%	51.78%
Percentage of Lines	100%	35.99%	39.97%	24.04%

Note. Summary statistics weighted by appropriate number of lines.

Table 5 -- GMM Estimates of Urban Price Equations

(Std. Errors in parentheses * denotes significant at 10% level, ** denotes significant at 5% level)

	Residential	Residential	Business	Business	Access	Access
APCM	0.0107 **	0.0073 **	0.0090 **	0.0123 **		
	(0.003)	(0.003)	(0.004)	(0.005)		
BPCM	-0.0043 *	-0.0007			0.0058 **	0.0060 **
	(0.001)	(0.001)			(0.002)	(0.002)
RPCM			-0.0020	-0.0024	0.0102 **	0.0090 **
			(0.002)	(0.002)	(0.003)	(0.003)
RUR RPCM		0.0193 **		-0.0145 **		-0.0060
		(0.004)		(0.007)		(0.004)
Marginal Cost	0.0045 **	0.0047 *	0.0010	0.0026	0.0091 *	0.0071
	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.005)
RURAL POP	0.6839 **	0.5718 **	0.2436 *	0.4765 **	0.0509	-0.0374
	(0.091)	(0.097)	(0.126)	(0.175)	(0.133)	(0.152)
RURAL USF		0.0007		-0.0131 **		0.0084 *
		(0.003)		(0.003)		(0.005)
S271	0.0165	0.0569 *	-0.1525 **	-0.2044 **	-0.0481	0.0035
	(0.044)	(0.031)	(0.058)	(0.060)	(0.051)	(0.055)
CONTRIB					-0.0083 **	-0.0081 **
					(0.001)	(0.002)
REP GOV	-0.0581 **	-0.0343	-0.0873 *	-0.1399 **	-0.0103	-0.0199
	(0.029)	(0.026)	(0.052)	(0.059)	(0.029)	(0.033)
REP PUC	0.0796 **	0.1056 **	0.1016 **	0.0917 **	-0.0592 **	-0.0505 **
	(0.034)	(0.023)	(0.038)	(0.039)	(0.021)	(0.021)
ELECT	0.0678 *	0.0422	0.1368 **	0.1919 **	0.1001 **	0.0587
	(0.035)	(0.026)	(0.039)	(0.042)	(0.048)	(0.049)
PRICECAP	0.1778 **	0.1141 **	0.1025 **	0.1370 **	-0.1249 **	-0.0917 *
	(0.033)	(0.043)	(0.042)	(0.054)	(0.048)	(0.053)
Measured Service	-0.0152	-0.0754	-0.3394 **	-0.2573 **		
	(0.048)	(0.051)	(0.037)	(0.061)		
LCA	0.0006	0.0005			0.0024	0.0019
	(0.000)	(0.001)			(0.002)	(0.003)
POP-EMP	0.0229	0.0052	0.1082 **	0.1023 **	0.0672 **	0.0606 *
	(0.019)	(0.027)	(0.034)	(0.035)	(0.029)	(0.032)
EMPLOY			-0.0007	-0.0005	0.0002	0.0002
			(0.001)	(0.000)	(0.001)	(0.001)
SERVICE			-0.0471	-0.0104		
			(0.035)	(0.051)		
SMALL FIRMS			0.2032	0.3504		
			(0.230)	(0.289)		
AGE	-0.0083	-0.0751 **				
	(0.026)	(0.028)				
WHITE	-0.0098	-0.0286 **				
	(0.011)	(0.010)				
POVERTY	-0.0718 **	-0.1523 **				
	(0.035)	(0.048)				
PTLINES					0.0963 **	0.1502 **
					(0.051)	(0.065)
Constant	2.6001 **	2.7878 **	3.2920 **	2.9489 **	2.1680 **	2.1182 **
	(0.079)	(0.103)	(0.178)	(0.266)	(0.136)	(0.138)
Observations	1345	1345	1345	1345	1345	1345
Hansen J statistic	16.3770	18.256	20.254	14.572	23.275	19.387

Table 6 -- GMM Estimates of Rural Price Equations

(Std. Errors in parentheses * denotes significant at 10% level, ** denotes significant at 5% level)

	Residential	Residential	Business	Business	Access	Access
APCM	0.0030	0.0020	0.0046 *	0.0035 *		
	(0.002)	(0.002)	(0.002)	(0.002)		
BPCM	-0.0021	0.0041 *			0.0044	0.0072
	(0.002)	(0.002)			(0.004)	(0.005)
RPCM			-0.0010	0.0000	-0.0042	-0.0089
			(0.002)	(0.002)	(0.009)	(0.010)
URB BPCM		-0.0090 **		0.0058 *		-0.0045
		(0.003)		(0.002)		(0.007)
Marginal Cost	-0.0014	0.0036 *	-0.0018	-0.0006	0.0109	0.0056
	(0.002)	(0.002)	(0.002)	(0.002)	(0.015)	(0.018)
RURAL POP	0.3984 **	0.6246 **	0.3953 **	0.2699 **	0.2115	0.3086
	(0.111)	(0.133)	(0.087)	(0.101)	(0.385)	(0.399)
USF	0.0021	-0.0005	-0.0008	0.0006	-0.0062 **	-0.0067 **
	0.0017	(0.002)	0.0017	(0.002)	0.0030	(0.003)
S271	0.0273	-0.0169	-0.0218	-0.0258	-0.8606 **	-0.8600 **
	(0.086)	(0.084)	(0.070)	(0.078)	(0.200)	(0.206)
CONTRIB					0.0058 *	0.0060 *
					(0.003)	(0.003)
REP GOV	-0.0336	-0.0726	-0.0600	-0.0224	0.2843 *	0.2601 *
	(0.046)	(0.047)	(0.047)	(0.044)	(0.155)	(0.157)
REP PUC	0.0943 **	0.1170 **	0.1101 **	0.0842 **	-0.0858	-0.0618
	(0.045)	(0.043)	(0.039)	(0.041)	(0.156)	(0.158)
ELECT	0.0358	0.0910	-0.0553	-0.0838 *	0.5283 **	0.5565 **
	(0.071)	(0.063)	(0.053)	(0.043)	(0.143)	(0.152)
PRICECAP	0.1133 *	0.1176 **	0.1310 **	0.0878 **	0.2557 *	0.2654 *
	(0.063)	(0.058)	(0.046)	(0.033)	(0.138)	(0.141)
Measured Service	0.0086	-0.0025	-0.0438	0.0063		
	(0.038)	(0.034)	(0.044)	(0.056)		
LCA HH	0.0025	0.0020			-0.0021	-0.0005
	(0.004)	(0.004)			(0.004)	(0.004)
POP-EMP	0.0081	-0.0038	0.0495 **	0.0471 **	-0.0127 **	-0.0221 *
	(0.016)	(0.016)	(0.013)	(0.013)	(0.043)	(0.044)
EMPLOY			-0.0031 **	-0.0019 *		
			(0.001)	(0.001)		
SERVICE			0.0680 **	0.0662 **		
			(0.028)	(0.023)		
SMALL FIRMS			-0.3771 **	-0.3324 **		
			(0.126)	(0.105)		
AGE	-0.1104 *	-0.0573				
	(0.059)	(0.062)				
WHITE	-0.0556	-0.0238				
	(0.045)	(0.043)				
POVERTY	-0.0934	-0.0008				
	(0.080)	(0.084)				
PTLINES					-0.6700 **	-0.6305 **
					(0.200)	(0.193)
Constant	2.8411 **	2.7280 **	3.5305 **	3.3697 **	2.2198 **	2.3220 **
	(0.117)	(0.103)	(0.157)	(0.159)	(0.290)	(0.382)
Observations	4212	4212	4212	4212	4212	4212
Hansen J statistic	14.98	14.778	17.441	17.138	15.286	15.226

APPENDIX Marginal Cost Estimates

We use the FCC's (2000) HCPM, which is used to distribute federal, high-cost universal service subsidies, as an input to determine the marginal cost of providing different services in different regions. The HCPM divides regions served by large carriers into roughly 12,493 geographic areas based on the current location of incumbent wire centers (or switches and customers served by a particular switch). For each wire center, the model estimates the forward-looking economic cost of the various components used to provide basic local telephone service: loop, switching, signaling and transport, etc. Based on the differences in local conditions, population density and other factors, the model estimates the total cost of providing local service in each wire center.

Estimates of marginal cost for loop plant and switch ports were obtained by estimating a second-order Taylor series using HCPM estimates of total loop and port costs (*TOTAL COST*) for a wire center Estimates of the marginal cost of retail service provision are obtained from a regression of *TOTAL COST* on the number of business lines (*BUS LINES*), number of residential lines (*RES LINES*), number of special access lines (*SA LINES*) and geographical area of the wire center (*AREA*). Estimates of the marginal cost of network access provision are obtained from a regression of *TOTAL COST* on the number of total lines (*TOTAL LINES*), (i.e., the sum of residential, business and special access lines) and *AREA*. Cost function estimates are reported in Table 7.

Table 7.
Cost function estimates

Independent variable	Retail cost function estimates	Access cost function estimates
BUS LINES	12.1373	-
	(1.0298)	
RES LINES	22.1752	-
	(0.5233)	
SA LINES	11.8496	-
	(0.9480)	
TOTAL LINES	-	17.5610
		(0.1870)
AREA	184.109	183.778
	(26.889)	(31.240)
BUS LINES^2	-0.00003	-
	(0.00001)	
RES LINES^2	-0.00005	-
	(0.00001)	
SA LINES^2	-0.00005	-
	(0.00001)	
TOTAL LINES^2	-	-0.00002
		(0.00000)
AREA^2	-0.06584	-0.07034
	(0.01763)	(0.02064)
BUS LINES×RES LINES	0.00004	-
	(0.00003)	
BUS LINES×SA LINES	0.00006	-
	(0.00003)	
RES LINES×SA LINES	0.00001	-
	(0.00002)	
BUS LINES×AREA	0.01465	-
	(0.00970)	
RES LINES×AREA	0.01635	-
	(0.00373)	
SA LINES×AREA	-0.02550	-
	(0.00599)	
TOTAL LINES×AREA	-	0.00813
		(31.2399)
Constant	32996.8	40194.9
	(2834.53)	(3187.82)
Observations	8197	8197
R^2	0.9791	0.9810

Note. Dependent variable is *TOTAL COST*. Robust standard errors in parenthesis.