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ABSTRACT

Product Market Competition and Lobbying Coordination in the U.S. Mobile Telecommunications Industry*

by Astrid Jung and Tomaso Duso

This paper empirically investigates market behavior and firms' lobbying in a unified structural setup. In a sequential game, where firms lobby for regulation before they compete in the product market, we derive a testable measure of lobbying coordination. Applying the setting to the early U.S. cellular services industry, we find that lobbying expenditures, as measured by campaign contributions, and market conduct were consistent with a one-shot Nash equilibrium and that price caps were binding on average. Furthermore, campaign contributions from cellular firms effectively lowered the burden of the price caps and reduced production costs.

Keywords: *Collusion, Lobbying, Price Cap, Regulation, Rent-Seeking, Interest, Groups, Telecommunication*

JEL Classification: *D72, L13, L51, L96, C31*

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ZUSAMMENFASSUNG

Produktmarktwettbewerb und Koordination im Lobbying in der U.S. Mobilfunkindustrie

Dieses Paper untersucht Marktverhalten und Lobbying durch Unternehmen empirisch in einem vereinheitlichten strukturellen Ansatz. In einem sequentiellen Spiel, wo die Firmen für Regulierung Lobbyismus betreiben, bevor sie im Produktmarkt konkurrieren, leiten wir ein testbares Maß für Lobbying-Koordination her. In einer Anwendung auf den frühen US Mobilfunkmarkt zeigen wir, dass Marktverhalten und Lobbying-Ausgaben (gemessen als Parteispenden) mit einem einfachen Nashgleichgewicht vereinbar sind und die Preisobergrenzen im Durchschnitt binden. Außerdem waren Parteispenden offenbar ein effektives Mittel um die Preisgrenzen zu lockern und kostenbezogene Regulierung abzumildern.

1 Introduction

Besides directly product related measures such as quantity and price, firms have a variety of tools at their disposal in order to maximize profits. Specifically, companies operating in regulated industries have an incentive to lobby politicians and bureaucrats for concessions. The way firms organize their interests and how much they are willing to invest in lobbying crucially depends on product market characteristics such as demand and cost conditions as well as the degree of competition. Hence, from a business perspective, lobbying expenditures and product market strategic variables are interdependent. Despite the intuitive appeal of this argument and ubiquitous evidence of rent seeking by individual firms or industry associations, economists have paid relatively little attention to the simultaneity of interest group formation and market behavior. Moreover, the political economy literature has not yet developed means to evaluate the degree of firms' coordination in their political activities based on lobbying data.

This paper investigates lobbying for regulation and product market competition. The empirical model is based on a two stage game, where firms lobby in the first stage and their political contribution is immediately rewarded by a policy response. In the second stage the firms set quantities. Instead of presupposing coordination among the firms, we identify and estimate one behavioral parameter in each subgame. The estimation of a coordination parameter in the lobbying game is possible because we explicitly specify the costs of lobbying and its gains in terms of product market profits.

Our theoretical model is tailored to the characteristics of the early U.S. mobile telecommunications industry. Estimating coordination in firms' lobbying activities calls for data of an industry with a number of comparable but independent lobbying and policy decisions. Being divided into many small geographical markets, which are exposed to varying forms of state specific regulation, the U.S. cellular industry is uniquely suited to investigate the interrelation between product markets and lobbying. During the sample period, the second half of the 1980s, the most notable aspect of regulatory power that was assigned to the individual states pertained to their discretion over price regulation. At that time a number of U.S. states had imposed price controls in the form of price caps.[1] Other state-level policy decisions, such as restrictions on the placement of cellular antennas, affect the profits of the cellular business through the production costs.[2] Both channels of state intervention, price caps and cost related regulation, rationalize rent seeking activities by mobile telecommunication operators.[3]

The term lobbying denotes a number of activities, some of which are either not reported or are impossible to quantify. In this paper, we measure firms' lobbying efforts by their contributions to the campaigns of political parties. In the U.S., campaign contributions are widely used by individual companies and industrial interest groups and have the additional advantage of being publicly disclosed.[4] They are a means for cellular operators to access to politicians who, in return, may change rules that affect firms' costs and adjust price caps or exert influence on the price regulating authority.

Our results suggest that, on average, product markets and lobbying were in a Cournot Nash equilibrium. In price-regulated states, price caps actually inflicted restrictions on firms' market conduct. Campaign contributions, as a means of influencing political and regulatory decisions, were effective in lowering the burden of the price caps and in reducing the production costs. We also find that the cost advantage achieved through campaign contributions varies significantly across firms. In particular, Bell companies seem to have profited in terms of greater cost reducing effects than their competitors.

Methodologically, this paper expands the structural empirical industrial economics (EIO) approach to the analysis of political economy questions. Empirical investigations of rent seeking coordination among firms are challenging, because, in order to identify the

[1] We interpret various types of regulation as being in effect a form of price cap regulation. See chapter 2 for details.

[2] For example, see the State Highway Maintainance Manual issued by the Wisconsin Department of Transportation (DOT), policies 96.31 and 96.41, which regulate longitudinal antenna installations on freeways: one among many requirements is that the utility shall pay a full-time inspector representing the DOT during the installation period. Although this example stems from a time after our sample period, it illustrates the cost-related state level regulatory issues in this industry.

[3] We abstract from lobbying for entry regulation, because the market structure of the U.S. mobile telecommunications industry was settled on a long-run basis at the federal level before the sample period. See Hazlett and Michaels (1993) for a rent seeking analysis of this process.

[4] Ansolabehre et. al. (2002) find a strong positive association between PAC (Public Action Committee) contributions and actual expenses of registered lobbyists.

economic primitives of the lobbying process, they require a theoretical model that includes the product market, regulation, and lobbying. The complexity of issues involved in the emergence and impact of specific policies explains why the literature in political economy has rarely adopted a structural approach for estimating interactions among agents.[5] We test the type of the lobbying game that firms play based on a conjectural variations concept as it has been used in EIO (see Bresnahan, 1989). The identification of this parameter relies on explicitly modeling the interactions between the market game and lobbying decisions. One of the advantages of the conjectural variations approach over other methods for identifying cooperation empirically, is its flexibility to cover different games in a single estimation. Furthermore, this method can be applied to aggregated market data and absent cost information. Of course, ignoring differences between the firms, the conduct parameter will only be valid on average. As another drawback, inference which is based on static conduct parameter measurement may lack statistical power if the underlying game is dynamic and demand states are not strongly correlated over time (Corts, 1999). Puller (2002) avoids this shortcoming by estimating conduct in an explicitly dynamic model.

A number of recent theoretical contributions have integrated market games, policy making and lobbying. Baron (1999) shows that firms lobby not only because of the direct effect regulation has on profits, but also to improve their competitive advantage compared to rivals, who might be less able to comply with the requirements imposed by the authorities.[6] However, he does not address the problem of how firms overcome the well known free rider problem in group formation (Olson, 1965) and achieve coordination. Other recent articles (Damania and Fredriksson, 2000 and 2002, and Ludema, 2001) focus instead on this point and explain lobbying formation as the outcome of an infinitely repeated game. They both show that coordination in product market, i.e. collusion, plays

[5] Exceptions include Goldberg and Maggi (1999), Gawande and Bandyopadhyay (2000), and Eicher and Osang (2002) who structurally test whether industrial lobbying has successfully influenced trade protection. Interest groups' lobbying decisions are, however, exogenous in these constributions.

[6] In a different modeling approach Grossman and Helpman (1994) study trade protection lobbying in a framework, where (exogenously given) interest groups bid contingent on future policy decisions. They do not, however, model the market game, even though they show that competition among rivaling interest groups shapes their policy preferences.

a central role in explaining lobbying group formation.

Our model assumes that policy decisions may affect firms' production costs. Thus, firms have an incentive to lobby for alleviating cost increasing regulations. This argument makes costs endogenous to the market game. Ignoring this endogeneity biases the inference about market conduct. Röller and Sickles (2000) give an example of how the endogeneity of costs matters in the context of measuring market power in the airline industry.

A number of recent papers (Besley and Case, 2000; Duso and Röller, 2003; and Duso, 2003) indicate the importance of the endogeneity of regulation for the assessment of market outcomes, but do not identify its sources. Our paper explicitly models lobbying by firms as a cause of the endogeneity of regulation.

In this paper, we use the same market data as Parker and Röller (1997), who find that prices in the cellular industry were, on average, higher than in a Cournot-Nash equilibrium and that conduct depended on exogenous product market characteristics. The results that we obtain in an earlier contribution indicate that firms' campaign contributions are endogenous with respect to the market game and that their level has an impact on market conduct (Duso and Jung, 2002). The inference in that paper is, however, based on a combination of a structural market model with a descriptive lobbying equation.

The paper proceeds as follows. Section 2 briefly describes the U.S. cellular market and the data. In section 3 we develop a structural model of product market interactions and lobbying decision and derive the first order conditions. Section 4 is devoted to the empirical implementation. Section 5 discusses the estimation results, and section 6 concludes.

2 The Data

The regulatory and market environment in the U.S. cellular industry in the second half of the 1980's are unique and constitute an excellent natural experiment for analyzing the relationship between lobbying and competition. On the one hand, we observe, for production as well as political decisions, many geographically separated markets within a single industry (for the former, the Metropolitan Statistical Areas and for the latter, the states). This fact guarantees enough heterogeneity – in the sense of statistical variation – to investigate the empirical interrelation between market-level collusion and state-level lobbying.

On the other hand, the product market is homogeneous, which justifies the same functional specification for the demand and first order condition across markets. Moreover, because of the homogeneity of the institutional environment across U.S. states, unobserved heterogeneity in the estimation of the lobbying equation is minimized.

Another important characteristic of the U.S. mobile telecommunications industry is that the market structure was exogenously determined during the entire sample period. Each of the considered markets started in the middle of the 1980's as a monopoly and was subsequently opened up to a second firm. This peculiarity allows us to concentrate on market conduct in a specified market structure and to rule out more complex games, where firms make their production decisions under the pressure of potential entry.

The database that we use is remarkably rich and covers the sample period 1985-1988. It contains product market variables such as prices, output, demand, cost, and market structure variables and information about the regulatory and political environments, such as the structure of the regulatory body and the composition of the states' governments and legislatures. Furthermore, it provides data on firms' political activities measured by their campaign contributions to political parties.

Part of the data has been already exploited in other studies. The market data were collected and used by Parker and Röller (1997), and we aggregated them to yearly observations in order to match the lobbying data.[7] The political data originates form the *Book of the States* and from the *U.S. Statistical Abstract*. The data on political contri-

[7] The market data originate from many different sources, such as *Cellular Price and Marketing Letter*, *Information Enterprise*, *Cellular Business*, *Cellular Market Data Book*, *EMCI*, *BOMA Experience Exchange Report*, U.S. Department of Energy, U.S. Department of Labor, Bureau of Labor Statistics, U.S. Department of commerce, and Bureau of Census. We refer the interested reader to Parker and Röller (1997) for a more precise description of the market data. We are very grateful to Phil Parker and Lars-Hendrik Röller for allowing us to use their data.

butions were kindly provided by the Center of Responsive Politics that elaborates figures stemming from the Federal Election Commission.[8]

Table 1 reports a brief description of the variables used in this study, whereas tables 2 and 3 contain the preliminary statistics. The first column of table 2 refers to the full sample, in which observations do not follow a specific periodicity. The aggregated sample represented in the second column of the table denotes the average observation for a given year calculated to match the market variables to the lobbying data, which is observed on a yearly basis. As a result the new market data contains one to four yearly observations for each of the considered 122 metropolitan markets. The differences in the mean and standard errors of the variables between the two samples are very small and not statistically significant.

Apart from market price (P) and quantity (Q),[9] we have information on demand shifters like the market population (POP), annual income per capita (INCOME), population density (DENSITY), and the number of high potential business establishments (BUSINESS). The data on cost shifters include the cost of energy (ENERGY), office and operation costs (RENT and OPERATE), labor costs in the cellular industry (WAGE), and cost of capital (PRIME). A dummies equal to one indicates duopoly periods (ENTRY).

During the sample period a number of US states had imposed explicit or implicit price caps on cellular tariffs. We denote price regulation as implicit price cap regimes, when cellular service prices must be approved by the Public Utility Commission (PUC), which beforehand does not publicly disclose critical price levels. Three U.S. states adopted a modified version of profit regulation. We also include these states in the set of states with implicit price cap regimes, because the operators' costs were rarely investigated by the authorities (see Shew, 1994). Based on the categories used by Shew we define the variable

[8]In particular, we thank Douglas Weber from the Center for Responsive Politics for making available the unpublished data on political contributions for our sample period.

[9]The price of a singular cellular operator is defined as the monthly bill paid by a costumer for 500 minutes of usage, assuming that he chooses the least expensive among the different plans offered. Since output levels are not directly observable, the quantity is proxied by the number of cellular antenna sites used by operators. Parker and Röller calculated from a sub-sample with available output measures a correlation index between the number of antennas and the number of subscribers equal to 0.92 (p-value < 0.0001).

PRICECAP such that it is equal to one in states where price caps or profit regulation was imposed or when the operators were required to file their tariffs with the PUC.[10]

In table 3 we report statistics for the political variables, which constitute a balanced panel with four yearly observations for each of the 40 states included in our sample. The information covers the composition of the different states' legislature and executive: a dummy equal to one if the governor came from the democratic party (GOVDEM), and the governor's salary (GSALARY). Variables related to the regulatory body are the Public Utility Commission's number of board members (PUCMEM), the length of their office (PUCTERM), their salary (PUCSALARY), and the number of full-time employees (PUCSTAFF). Indicators for election years (PRESELECT, FEDELECT, LEGISELECT) and for how close the state-level election results of the parties were to each other (TIGHT) are also included in the data set. Other potential controls for the lobbying process are the population of the state (POPSTATE) and its average income (INCSTATE). Finally, lobbying (LOBBY) represents the yearly aggregated campaign contributions from cellular firms operating in a state to candidates of that state who campaign in federal elections.

All political variables lag one year with respect to the market and lobbying data because a newly elected government needs some time before being able to implement policy changes.

3 A Sequential Model of Lobbying and Product Market Competition

In this paragraph we will introduce and discuss a model, which is designed to be the economic backbone of our estimations. Because we explicitly formalize the effect of lobbying expenditures on firms' profits, we are able to identify coordination in lobbying. Although a number of details and simplifications reflect the peculiarities of the U.S. mobile telecommunications industry or accommodate data limitations, the main body of the analysis could be applied to other industries as well.

[10] We exclude New York and South Carolina from the list of price cap regulated states. Officially these states imposed caps. The caps where, however, set by the companies.

Reflecting the structure of the U.S. cellular industry with its regional markets and state-level price regulation, the model considers firms (i), which are active in product markets (m) within states (s). Time subscripts are omitted.

We assume that the operators in each market supply a homogenous good in a quantity game.[11] They face an inverse market demand function, $P\left(Q_{ms}, X_{ms}^{D}\right)$, where Q_{ms} is the total quantity produced in this market and X_{ms}^{D} denotes a vector of demand characteristics.

Production costs are modeled as a firm-specific function, $C_i\left(Q_{ims}, L_s, X_{ms}^{C}\right)$, which includes as arguments the firm's quantity, Q_{ims}, the total lobbying expenditures of the industry at the state level, L_s, and market specific cost drivers, X_{ms}^{C}. The interpretation of lobbying expenditures as a cost shifter implicitly assumes that firms lobby in order to push policy decisions which decrease their costs. These decisions generally cover a range of aspects such as production related taxes or legal requirements. An example from the cellular industry are restrictions issued by each state on the placement of antennas. The diversity of regulatory issues that potentially affect costs raises the problem of how the individual policies are influenced by the firms and how multidimensional regulation relates to costs. Because in our empirical study we apply a broad measure of lobbying, which cannot be linked to specific policy decisions, we omit the regulatory decisions and include lobbying expenditures directly into the cost function. The assumption that aggregate rather than individual lobbying expenditures matter in C_i, implies that politicians and regulators make their decisions as a function of total lobbying expenditures, L_s, and regardlessly of who contributes the money. With this simplification it will be possible to estimate the model with industry-level lobbying data.

[11] Quantity competition is assumed, although the actual game in the early cellular industry is better understood as a pricing game with capacity constraints. For the two models to be equivalent, equilibrium prices in the latter must be such that the capacity constraint is binding (see Kreps and Scheinkman, 1983). For the U.S. cellular industry, where capacitity is determined by the number of antennas, while the number of subscribers or air time minutes reflect actual production, we argue that the equivalence holds at least approximatly during the industry's early development phase for two reasons. First, upon receiving licenses from the Federal Trade Commission, operators were not obliged to immediately cover the entire market with antennas. The data reveals that, indeed, the licencees did not install a huge capacity in the beginning of their business, but rather extended their networks steadily. Second, capacity and production measured by the number of subscribers are closely related (see footnote 9).

During our sample period, a number of U.S. states regulated cellular tariffs. Although the precise design varied, in practice, price regulation explicitly or implicitly established price caps denoted by $\overline{P}_s$. The price cap, where actually binding, establishes an incentive for the constrained firms to influence it. Therefore, we assume that $\overline{P}_s$ reflects the value of a function $\overline{P}\left(L_s, X_s^P\right)$, which depends on the industry's lobbying expenditures and state characteristics, X_s^P. In contrast, we exclude the possibility that lobbying by the cellular operators affects the regulatory regime, i.e. on whether a state imposes price regulation at all.[12]

We establish firms' maximization problem assuming that the regional markets are independent except for being exposed to the same regulation within a state. Hence, deciding about lobbying expenditures and production, a firm i operating in M_{is} markets within state s maximizes its profits, Π_{is}, at the state level:

$$\Pi_{is} = \sum_{m=1}^{M_{is}} \left[P\left(Q_{ms}, X_{ms}^D\right) Q_{ims} - C_i\left(Q_{ims}, L_s, X_{ms}^C\right)\right] - L_{is}, \tag{1}$$

with respect to Q_{ims} and L_{is} and subject to the constraint

$$R_s\left[\overline{P}\left(L_s, X_s^P\right) - P\left(Q_{ms}, X_{ms}^D\right)\right] \geq 0, \tag{2}$$

where $R_s = 1$ if state s imposes price caps, otherwise zero.[13] Since, in our model, lobbying is formalized as expenditures, L_{is} in (1) reflects the individual cost of lobbying. Because firms lobby at the state level, their lobbying costs are deducted from the profits which they earn in all markets within a state.

We consider lobbying and quantity setting in a sequential game: First firms decide simultaneously on their lobbying expenditures and observe its immediate effect on price

[12]This assumption is motivated by the data. The regimes were determined before the markets actually started to operate and very rarely changed. Amendments occurred only towards less regulation, reflecting a general political trend during the 80s. Within our model firms in regulated states can de facto abolish the price cap by increasing it through lobbying to a sufficiently high level.

[13]Strictly speaking, price cap regulation implies for each firm i a residual inverse demand function with a kink at a critical quantiy $\overline{Q}_{ims}$ that is derived from market demand at a price $\overline{P}_s$ and the rivals' production. For $Q_{ims} \leq \overline{Q}_{ims}$ the inverse residual demand is flat at the level of $\overline{P}_s$, while for $Q_{ims} \geq \overline{Q}_{ims}$ it has the same shape as without a price cap. Provided the usual regularity conditions for demand hold, profit maximization involving such a kinked inverse demand is analytically identical to maximizing profits with the original inverse demand function and subject to (2).

caps and costs. Then they set quantities simultaneously.[14] In order to empirically analyze the degree of cooperation at both stages within the conjectural variations framework, it is sufficient to derive first-order conditions for the one-shot game. The following solves the game by backward induction, starting with the second stage.

Since we assume that the product markets within a state are only related by being exposed to the same policy, which is exogenous to the second stage game, quantity decisions are made independently for each market. The Kuhn-Tucker conditions for an optimal quantity choice corresponding to the objective (1) and the constraint (2) are

$$\begin{aligned} 0 &= \frac{\partial P(\cdot)}{\partial Q_{ms}} \theta^Q_{ims} I_{ms} \left(Q_{ims} - \phi_{ims} R_s \right) + P(\cdot) - \frac{\partial C_i(\cdot)}{\partial Q_{ims}}, & (3) \\ 0 &\leq R_s \left[\overline{P}(\cdot) - P(\cdot) \right], & (4) \\ 0 &= \phi_{ims} R_s \left[\overline{P}(\cdot) - P(\cdot) \right], \text{ and} & (5) \\ 0 &\leq \phi_{ims}, & (6) \end{aligned}$$

where I_{ms} is the number of firms in market m within state s and ϕ_{ims} denotes the Lagrange multiplier for firm i's m^{th} constraint in state s. Depending on assumptions about firms' behavior, θ^Q_{ims} is equal to zero (if a market is perfectly competitive), to $1/I_{ms}$ (in a Cournot-Nash equilibrium), and to 1 (in a monopoly or symmetric cartel).

Equation (3) reduces to the usual first order condition in unregulated markets within unregulated states ($R_s = 0$) or in cases where the price cap is not binding ($\phi_{ims} = 0$). When the cap is binding, then (3) reflects that marginal revenues now exceed marginal costs by $-\phi_{ims} \partial P / \partial Q_{ms} \geq 0$ at the quantity level which would be optimal without price regulation. Provided that, in the relevant range, marginal revenues are decreasing and marginal costs increasing in quantity, the optimal regulated quantity must be greater than the unregulated one.

Empirically, θ^Q_{ims} is a measure of conduct. It is equal to one plus the conjectural

[14] It is straightforward to set up an alternative model where firms choose lobbying expenditures and quantities simultaneously. In order to be reasonable in the current context, such a model requires lobbying to affect policy with a lag – otherwise it would imply that firms do not observe the price cap which actually applies to their production decisions. The sample in our empirical application is too short in the time dimension and too unbalanced to accommodate the lagged version.

variation standardized by the number of competitors,[15]

$$\theta_{ims}^{Q} := \frac{1}{I_{ms}} \frac{dQ_{ms}}{dQ_{ims}} = \frac{1}{I_{ms}} \left(1 + \sum_{j=1, j \neq i}^{I_{ms}} \frac{\partial Q_{jms}}{\partial Q_{ims}} \right).$$

Before competing in the product markets, each firm decides about its lobbying expenditures at the state level. In the lobbying game, the first-order condition of firm i in state s is given by

$$\begin{aligned} 0 &= \theta_{is}^{L} I_s \sum_{m=1}^{M_{is}} \left[\frac{\partial P(\cdot)}{\partial Q_{ms}} \sum_{j=1}^{I_{ms}} \frac{dQ_{jms}^{*}}{dL_s} \left(Q_{ims}^{*} - \phi_{ims} R_s \right) + \left(P(\cdot) - \frac{\partial C_i(\cdot)}{\partial Q_{ims}} \right) \frac{dQ_{ims}^{*}}{dL_s} \right. \\ & \left. - \frac{\partial C_i(\cdot)}{\partial L_s} + \phi_{ims} R_s \frac{\partial \overline{P}(\cdot)}{\partial L_s} \right] - 1, \end{aligned} \tag{7}$$

where I_s represents the number of firms in state s, the term dQ_{ims}^{*}/dL_s accounts for firm i's quantity reaction following all lobbying decisions, and the asterisks indicate the profit maximizing quantity choices at the second stage. The marginal cost of lobbying expenditures is naturally equal to one and, in an optimum, just balances the marginal gain from lobbying, which occurs on those product markets, where the firm operates. The product market profits are affected by lobbying through a number of channels. The first addend within the brackets reflects that aggregate lobbying expenditures change the market price indirectly through quantity adjustments. A price increase boosts revenues, but, on the other hand, tightens the constraint imposed by the price cap. The second addend incorporates the more direct revenue effect due to a quantity change and the costs of the quantity adjustment following lobbying. $\partial C_i(\cdot)/\partial L_s$ captures the effect of lobbying on costs and $\phi_{ims} R_s \partial \overline{P}(\cdot)/\partial L_s$ denotes the price cap's change due to successful lobbying, which is worth $\phi_{ims} R_s$. All of these effects occur in all markets within the state where firm i lobbies. However, their relevance hinges on what firm i expects would happen to aggregate lobbying expenditures, given its own change in L_{is}. Thus, it is straightforward

[15] A standardized conduct measure establishes a monotonic relationship between conduct and equilibrium choices of endogenous variables, irrespective of the number of players. This is important for empirical analysis where conduct is estimated as a constant parameter for observations with a varying number of players.

to derive a conduct interpretation of the parameter θ_{is}^{L} defined as

$$\theta_{is}^{L} := \frac{1}{I_s}\frac{dL_s}{dL_{is}} = \frac{1}{I_s}\left(1 + \sum_{j=1, j\neq i}^{I_s} \frac{\partial L_{js}}{\partial L_{is}}\right),$$

where the second addend is the conjectural variation of firm i. In the lobbying context, the conjectural variation represents how a firm expects other players will respond should it change its lobbying contribution. In a Cournot-Nash game players do not take the reactions of their rivals into account, hence $\theta_{is}^{L} = 1/I_s$. A game of perfect competition in lobbying would be characterized by firms expecting other firms to accommodate their behavior such that total lobbying is unaffected. This implies $\theta_{is}^{L} = 0$. If firms are cartelized, they internalize the effects of their own actions on the profits of the other cartel members. It is straightforward to derive that with symmetric cartelized firms θ_{is}^{L} must be equal to one.

4 Empirical Implementation

The empirical implementation of the above model involves the specification and estimation of the inverse market demand function $P(\cdot)$, the conditions (3)-(6), and equation (7). Throughout this section, Greek characters denote parameters. Exogenous variables, as well as their corresponding parameters, should be read as vectors. Time subscripts are omitted, because, with our panel data being very short and unbalanced, we abstract from time effects in residuals.

Following Parker and Röller (1997) we specify a semilogarithmic inverse demand function:

$$P_{ms} = \beta_0 + \beta_1 \ln Q_{ms} + \beta_2 X_{ms}^{D}. \tag{8}$$

The marginal cost function is approximated by

$$\frac{\partial C_i(\cdot)}{\partial Q_{ims}} = \alpha_0 + \alpha_1 Q_{ims} + \alpha_2 L_s + \alpha_3 X_{ms}^{C}, \tag{9}$$

where $\alpha_2 L_s$ denotes the effect of lobbying expenditures on marginal costs. In the estimations we will also allow α_2 to vary with i in order to reflect differences in the firms' ability to follow regulatory requirements.

We assume that in price regulated states, the price cap function of $\overline{P}\left(L_s, X_s^P\right)$ is linear in lobbying expenditures and exogenous variables such that the first derivative equals

$$\frac{\partial \overline{P}\left(\cdot\right)}{\partial L_s} = \delta_0 + \delta_1 X_s^P. \tag{10}$$

The remainder of this section discusses the empirical implementation of the decision rules for quantity setting and lobbying with the above specifications.

Unless a price cap is not constraining the behavior of the firm, equation (3) is not a first order condition on its own. When a cap binds, production will be determined by the demand function at the point where the price equals the cap. In this case (3) expresses the deviation of the unconstrained from the constrained optimum identifying the shadow price of the constraint, ϕ_{ims}. Estimating quantity based on equation (3) ignores a censoring problem in the observed quantity, since Q_{ims} cannot not be smaller than some $\overline{Q}_{ims}$, which is derived from the price cap and the production of rivals. Censoring due in this case, is usually accommodated by deriving a likelihood function that depends on whether the constraint is binding or not (see Wales and Woodland, 1982). For the cellular industry data in our study we do not observe the price cap. In fact, in some states, where tariffs were subject to approval by the PUC, the caps were only implicit. Thus, we are not able to distinguish observations where $Q_{ims} = \overline{Q}_{ims}$.[16] For this reason estimations in this paper are based on (3) and ignore potential censoring of regulated quantities.

By summation over the rivals in a market, we derive an empirical quantity relation at the market level,

$$0 = -\alpha_0 - \alpha_1 \frac{Q_{ms}}{I_{ms}} - \alpha_2 L_s - \alpha_3 X_{ms}^C + P_{ms} + \theta^Q \beta_1 \left(1 - \phi R_s \frac{I_{ms}}{Q_{ms}}\right), \tag{11}$$

which we will estimate with the fixed parameters $\phi_{ims} = \phi$ and $\theta_{ims}^Q = \theta^Q$ and imposing $\theta^Q = 1$ for monopoly markets. Equation (11) allows us to estimate firms' conduct based on market-level data.[17] As a drawback of working with market-level data, we are not able

[16] In principle $\overline{P}$ could be estimated from the observed lobbying expenditures and other variables. However, due to the lack of a full structural model for the policy choice such estimates cannot be expected to be precise enough to sort out the binding constraint cases from the data in a satisfactory way.

[17] Note that equation (11) has two solutions in the endogenous variable Q_{ms}. One of these solutions is excluded by concavity of the maximization problem in Q_{ims} (sufficient condition: $\alpha_1 \geq 0$, $\beta_1 \leq 0$) and the fact that the parameters θ^Q and ϕ as well as the optimal quantity must be positive.

to identify differences among firms in their marginal cost functions, their conjectures, and the Lagrange parameter. In a homogeneous good setting, where all firms within a market face the same demand function, symmetric costs and conjectures imply $Q_{ims} = Q_{jms}$, hence $Q_{ms} = I_{ms}Q_{ims}$.

The empirical implementation of the lobbying equation (7) requires an explicit expression for the reaction of each firm's production to changes in aggregate lobbying, dQ^*_{ims}/dL_s. Applying the implicit function theorem to the firm-level version of the quantity relation (11) we have

$$\frac{dQ^*_{ims}}{dL_s} = \frac{\alpha_2}{\theta^Q \beta_1 \frac{I_{ms}}{Q_{ms}} \left(2 + I_{ms}\theta^Q \left(\frac{\phi R_s}{Q_{ms}} - \frac{1}{I_{ms}}\right)\right) - \alpha_1}, \tag{12}$$

which is identical for all firms. If the estimate (12) is significantly different from zero, this would reject a model where lobbying and quantity decisions are made simultaneously.

With (12) the empirical lobbying equation aggregated to the state level is

$$\begin{aligned} 0 \;=\; & \theta^L \sum_{m=1}^{M_s} I_{ms} \frac{\alpha_2 \left(\beta_1 \left(1 - \phi R_s \frac{I_{ms}}{Q_{ms}}\right) + P_{ms} - \alpha_0 - \alpha_1 \frac{Q_{ms}}{I_{ms}} - \alpha_2 L_s - \alpha_3 X^C_{ms}\right)}{\theta^Q \beta_1 \frac{I_{ms}}{Q_{ms}} \left(2 + I_{ms}\theta^Q \left(\frac{\phi R_s}{Q_{ms}} - \frac{1}{I_{ms}}\right)\right) - \alpha_1} \\ & + \theta^L \left(\phi N_s R_s(\delta_0 + \delta_1 X^P_s) - \alpha_2 Q_s\right) - 1, \end{aligned} \tag{13}$$

where M_s is the number of markets in state s, Q_s denotes the cumulative production in s, and $N_s = \Sigma_i^{I_s} \Sigma_m^{M_{is}} 1$. Again, we estimate an average conduct parameter, $\theta^L_{is} = \theta^L$. Note that the marginal cost of lobbying expenditures is equal to one and, therefore, the same for all firms. However, unlike the consequences of symmetric cost on the quantity decision discussed earlier, this does not imply identical lobbying expenditures by all firms, because, by operating in a varying number of markets with different characteristics, each firm has an idiosyncratic marginal benefit from its political activities.

The estimations involve equation (13) and, according to the number of markets within a state (M_s), multiple equations of types (8) and (11).[18] The parameter θ^Q is identified,

[18] In all iterations we restricted ϕ to be greater or equal to zero. While this might have had an effect on the search direction for the parameter estimates, it was not a binding constraint upon convergence. Imposing the remaining Kuhn-Tucker conditions $\overline{P}(\cdot) - P(\cdot) \geq 0$ and $\phi\left(\overline{P}(\cdot) - P(\cdot)\right) = 0$ could improve the efficiency of the delta and beta parameters. Since ϕ is estimated as a constant and, furthermore, because we consider the empirical implementation of $\overline{P}(\cdot)$ and $P(\cdot)$ as approximations to their true functional form, we refrain from imposing these additional requirements.

because we allow market conduct to vary with market structure requiring $\theta^Q = 1$ for monopolies. For the identification of (13) note that θ^Q, ϕ, alphas, and betas are identified from the inverse demand equation and from (11). The conjectural variations parameter, θ^L, is identified by imposing $\theta^L = 1$ if only one firm operates in the state ($I_s = 1$). Identification of δ_0 and δ_1 is then straightforward.

We apply a full information maximum likelihood estimation (FIML) as described in appendix A assuming normally distributed error terms.

5 Estimation Results

5.1 Basic Model

In our baseline regressions the focus is on the average effect of lobbying. Estimates from two specifications are displayed in tables 4 and 5 in appendix C. In the first table the effect of lobbying on price caps takes into account a number of characteristics of the Public Utility Commission (PUC), while the second controls for state characteristics in the effect of lobbying on price caps.[19]

Despite the differences in the specification, the results from tables 4 and 5 are very similar.[20] The variables influencing marginal production costs are highly significant. Marginal costs increase in the factor prices WAGE and RENT as well as in output, the latter suggesting diseconomies of scale. The apparent increase of costs over the years is likely due to the variation of other input prices over time.[21]

On average, firms' campaign contributions apparently decrease marginal costs. In other words, campaign funding seems to open politicians' doors to the interests of cellular firms in alleviating cost increasing regulation. The empirical significance of α_2 is also

[19]Estimating a model containing the full set of PUC and state variables lead to problems in empirically identifying all of their parameters.

[20]The estimates in the inverse demand equation and marginal cost function qualitatively reproduce the findings by Parker and Röller (1997).

[21]The cost factors ENERGY, OPERATE, and PRIME were omitted in the final specification, because their effect appeared to be collinear to the effects of the year and RENT. The inference regarding the impact of the industry's campaign contributions on costs is not affected by this omission.

evidence in favor of the sequential and against a simultaneous model.[22]

On the demand side, all variables are significant and have the expected sign: The consumers' willingness to pay for cellular services increases over time and is higher in markets that are large in terms of population, in markets with many business establishments, and in rich and densely populated areas.

The results of both regressions suggest that the marginal effect of campaign contributions on price caps is significant and positive. This implies that firms' lobbying activity was successful and higher efforts have been rewarded with a more favorable price regulation[23] The coefficients of the PUCTERM, PUCSAL, PUCSTAFF indicate that campaign contributions have been more effective in increasing the price cap when the PUC's members were in office for a longer term and had higher salaries and when the PUC employed more staff. Intuitively, longer office terms help lobbyists to establish a mutual beneficiary relationship with regulators, while high monetary compensations for PUC officials might reduce their bias towards organized interest groups. In addition, the larger a regulatory body is, the more difficult it is for the lobbyists to locate appropriate contact persons and to woo all bureaucrats who are involved in cellular price regulation. State characteristics significantly influencing the price cap effect are population and per capita income.

The average conduct in duopoly markets is in both specifications around 0.5 and significantly different from 1 (cartel behavior) as well as from 0 (perfect competition). The hypothesis of Cournot Nash conduct, i.e. $\theta^Q = 0.5$, is not rejected at any usual significance level. Hence, the cellular services markets in our sample seem to be in a Cournot equilibrium, on average. This finding contradicts the result by Parker and Röller (1997), who conclude that cellular service prices were on average higher than in a noncooperative

[22] For a rigorous statistical test we would have to evaluate the empirical significance of dQ^*_{ims}/dL_s as specified in (12) taking into account the variation of all variables and parameter estimates in the denominator.

[23] In both, table 4 and 5, $\widehat{\delta}_0$ is significant only at the 10% level. The loose relationship between campaign ccontributions and price caps may result from the fact that campaign contributions are not a perfect measure of firms' attempt to influence price regulation. Indeed, the connection between campaign contributions and price caps is more indirect than the link between contributions and cost reducing policy decisions: While politicians have a very direct impact on the laws passed, they can only try to exert influence on members of the Public Utility Commissions, who eventually decide on the level of price caps.

duopoly.[24]

The estimate of the average lobbying coordination in states with more than one cellular firm is around 0.5. Note that the lobbying conjectural variation corresponding to a Nash equilibrium is $1/I_s$. The mean of I_s in our sample is 2.55 with a standard deviation of 1.12. Thus, θ^L would on average equal 0.392 with a standard deviation of 0.169 in a Nash equilibrium. Ignoring the variation of I_s, the estimated lobbying conduct in tables 4 and 5 is not significantly different from Nash behavior (at significance levels of 1% or 5%).

With $\widehat{\phi}$ being positive and significant, both specifications suggest that price caps in regulated markets imposed binding constraints on the firms' quantity decisions.

5.2 Firm-Specific Cost Advantages From Lobbying

The estimates discussed above build on the assumption that all firms within a state have the same marginal cost reduction and the same price cap increase. This implies that, at least for identical firms, the regulation that the cellular operators try to affect via campaign contributions is a public good among them. We now allow for asymmetry across firms with regard to their individual benefit from lobbying in terms of reducing production costs. Hence, we estimate a system of equations as before, with the difference that α_2 is now firm specific.[25]

The figures displayed in table 6 are the results obtained from a specification which controls for PUC characteristics as in table 4. Estimates analogous to those in table 5 are very similar and omitted. Table 6 shows that, although campaign contributions lead to a reduction in marginal costs for all firms, some companies were able to achieve substantially larger cost cuts than others.[26,27] For the lower part of table 6 we reestimated the system

[24] We also find Nash behavior in the Cournot game by estimating inverse demand and the quantity relation with exogenous lobbying ($\theta^Q = 0.64$, t-value 1.244 for the difference to Nash behavior and 3.2 for the null hypothesis of cartel). The remaining market parameters are very similar to those displayed in tables 4 and 5 with the notable exception of ϕ, which is not significant. Hence, ignoring the endogeneity of lobbying seems to underestimate the relevance of the price caps in regulated markets. Consequently, we would underestimate the effectiveness of the price regulation applied to the cellular industry, if its endogeneity induced by the firm's incentive to lobby, is ignored.

[25] The necessary adjustments to the estimation equations are discussed in appendix B.

[26] Table 6 excludes most estimates, since they were very similar to those displayed in tables 4 and 5.

[27] As noted in appendix B, firm varying α_{2i} imply that firms' quantities within each market will generally

with only three categories of firms. It becomes evident that campaign contributions were most effective in reducing costs for the Bell companies, the regional remains of AT&T after its divesture. With the argument that the market for local calls is a case for natural monopoly, these Bell companies were assigned monopoly rights in a regulated environment. In this light, the results of table 6 suggests that Bell companies were able to profit from their long-term relationship with regulators and politicians by obtaining a competitive advantage to the expense of other carriers.[28]

5.3 Robustness Checks

We do not have information on all markets within a state. Therefore, the estimation of the lobbying equation (13) might be prone to measurement bias, because it aggregates market information. Due to the nonlinearity of (13) it is impossible to predict the direction of the potential bias. For this reason we evaluated the robustness of all results discussed in this section by only using the data of those states and times for which our market data covers at least 50% or 80% of the population with access to cellular services.[29] For 116 states our observations cover at least 50% of the population with access to cellular services (279 markets). Requiring at least 80% coverage of the on-line poulation, reduces the number of state and market level observations to 116 and 178, respectively. While some estimates lose significance, none of our results regarding hypotheses about conduct, the price cap constraint, the effect of lobbying on costs, and its asymmetry across firms are affected by this. However, some of models with firm effects did not converge anymore.

differ. With only market-level data available, the specification of the lobbying equation in (13) is based on averaging, since it relies on the assumption that $Q_{ims} = Q_{ms}/I_{ms}$. In order to test the reliability of the α_{2i} estimates in table 6, we also estimate the market equations separately, because the market-level quantity relation is additively separable in Q_{ims} and thus not sensititve to asymmetry. With the caveat of ignoring the endogeneity of lobbying, the results confirm the findings shown in table 6.

[28]The difference between Bell companies and their independent rivals might also be due to the former having more experience with regulation in the telecommunication sector, which lead them to learn that they were more effective in lobbying for cost-reducing measures than in attempting to persuade regulators to set higher price caps. This argument put forward by Teske (1991) is, however, beyond the scope of our model.

[29]The results of the robustness checks are not displayed in the appendix but they can be obtained from the authors upon request.

6 Conclusions

This paper applies established methods from the field of empirical industrial organization to political economy questions. We provide a unified structural framework for the simultaneous study of firms' product market strategies and their interaction in lobbying for regulation. This enables us to perform statistical inference about the primitives of the lobbying decision and to test the type of the game that firms play. Based on conjectural variations we derive an empirical measure for the political coordination of firms and identify it through the interactions between the market game and lobbying.

We also acknowledge that firms have an incentive to persuade politicians to alleviate cost increasing regulation. To the extent that firms successfully lobby for political decisions that reduce their costs, production costs are endogenous. Ignoring the endogeneity biases the inference about firms' product market conduct.

Applying our model to the early U.S. cellular telecommunications industry, we find that, on average, product markets and lobbying, as measured by political campaign contributions, were in a Cournot Nash equilibrium. In regulated states price caps inflicted restrictions on firms' market conduct. The observed campaign contributions were apparently effective in both, lowering the burden of the price cap and reducing the production costs.

The cost effect of campaign contributions is very significant and suggests that costs are indeed endogenous. Moreover, the cost advantage achieved through lobbying varies substantially across the cellular operators. In particular, Bell companies are found to have profited in terms of greater cost reducing effects. To investigate the reason for this apparent advantage of Bell companies it would be indispensable to extend the analysis to firm-level data.

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A The Log-Likelihood Function

The FIML estimation applied in this study matches the specific data structure: policy and lobbying decisions are taken at the state level but each state contains an idiosyncratic number of markets, M_s. Denote the vector of residuals for state s with $\boldsymbol{\varepsilon}_s$, with $\dim(\boldsymbol{\varepsilon}_s) = 2M_s + 1$. The residuals are a vector valued function $\mathbf{f}_s$ of all endogenous variables $\mathbf{y}_s = (P_{1s}, \ldots P_{M_s s}, Q_{1s}, \ldots Q_{M_s s}, L_s)'$ and all exogenous variables $\mathbf{x}_s$:

$$\boldsymbol{\varepsilon}_s = \mathbf{f}_s(\mathbf{y}_s, \mathbf{x}_s).$$

The log-likelihood of estimating equation (13), M_s inverse demand equations (8), and M_s quantity setting equations (11) by nonlinear FIML is

$$l = const + \sum_s \ln|\det \mathbf{J}_s| + \frac{1}{2}\sum_s \ln(\det \Sigma_s^{-1}) - \frac{1}{2}\sum_s \mathbf{f}_s'\Sigma_s^{-1}\mathbf{f}_s, \tag{14}$$

where Σ_s is the state specific covariance and $\mathbf{J}_s = \partial\mathbf{f}_s/\partial\mathbf{y}_s'$. Rewriting Σ_s yields

$$\begin{pmatrix} \Sigma_P & \Sigma_{PQ} & \Sigma_{PL} \\ \Sigma_{PQ} & \Sigma_Q & \Sigma_{QL} \\ \Sigma_{PL}' & \Sigma_{QL}' & \sigma_L \end{pmatrix},$$

where Σ_P and Σ_Q are covariance matrices of the inverse demand and supply equations respectively, while σ_L denotes the variance of the lobbying equation. The matrices Σ_{PL} and Σ_{QL} are the covariances between the market equations and the lobbying equation.

We assume that all markets and all states are independent and that all residuals of a specific type of equation are drawn from the same normal distribution with mean zero and variance σ_P, σ_Q, and σ_L. Thereby $\Sigma_P = \mathbf{1}_{M_s} \cdot \sigma_P$, $\Sigma_Q = \mathbf{1}_{M_s} \cdot \sigma_Q$, and $\Sigma_{PQ} = \mathbf{1}_{M_s} \cdot \sigma_{PQ}$, where $\mathbf{1}_{M_s}$ is a M_s-dimensional identity matrix and σ_{PQ} denotes the covariance between the inverse demand equation and the supply equation in the same market. Furthermore, let the covariance between the market equations and the state equation be such that (I) the general "affinity" of the state equation to a specific type of market activity (i.e., demand or supply) within this state is independent of the number of these markets and (II) the covariances between the state equation and all market equations of the same type in this state are equal. Assumption (I) is reflected by $cov(\varepsilon_{Ls}, \varepsilon_{Ps1} + \cdots + \varepsilon_{PsM_s}) = \sigma_{PL}$

and $cov(\varepsilon_{Ls}, \varepsilon_{Qs1} + \cdots + \varepsilon_{QsM_s}) = \sigma_{QL}$ while assumption (II) leads to $cov(\varepsilon_{Ls}, \varepsilon_{Ps1}) = \cdots = cov(\varepsilon_{Ls}, \varepsilon_{PsM_s})$ and $cov(\varepsilon_{Ls}, \varepsilon_{Qs1}) = \cdots = cov(\varepsilon_{Ls}, \varepsilon_{QsM_s})$. This implies that $cov(\varepsilon_{Ls}, \varepsilon_{Psm}) = 1/M_s\sigma_{PL}$ and $cov(\varepsilon_{Ls}, \varepsilon_{Qsm}) = 1/M_s\sigma_{QL}$ for all markets $m = 1, \ldots, M_s$. Hence, $\Sigma_{PL} = u_{M_s} \cdot \sigma_{PL}/M_s$ and $\Sigma_{QL} = u_{M_s} \cdot \sigma_{QL}/M_s$, where u_{M_s} is a M_s-dimensional column vector of ones. With this structure, the correlation between the lobbying equation and the sum of the residuals of the market equations of either type decreases in M_s.[30]

[30] In a sensitivity check, we imposed $\sigma_{PL} = \sigma_{QL} = 0$. The estimates are qualitatively not affected by this change.

B Estimation Equations with Firm-Specific Lobbying Effects

Allowing for firm specific cost reductions through lobbying requires the estimation of a firm specific parameter α_{2i} in the marginal cost function (9). This changes the empirical quantity relation (11) to

$$0 = -\alpha_0 - \alpha_1 \frac{Q_{ms}}{I_{ms}} - \frac{L_s}{I_{ms}} \sum_{i=1}^{F} \alpha_{2i} F_{ims} - \alpha_3 X_{ms}^C + P_{ms} + \theta^Q \beta_1 \left(1 - \phi R_s \frac{I_{ms}}{Q_{ms}}\right), \quad (15)$$

where F_{ims} is an indicator equal to one if firm i operates in market m in state s and F denotes the total number of firms in our sample.[31]

Adjusting the lobbying equation (13) to accommodate firm specific α_{2i}-parameters, requires firm-level quantity data, which are not available in our context. Therefore we estimate the adjusted version of (13) at the market average of production, Q_{ms}/I_{ms}:

$$\begin{aligned} 0 \;=\; & \theta^L \sum_{m=1}^{M_s} \sum_{i=1}^{F} \left[\frac{\alpha_{2i} F_{ims} \left(\beta_1 \left(1 - \phi R_s \frac{I_{ms}}{Q_{ms}}\right) + P_{ms} - \alpha_0 - \alpha_1 \frac{Q_{ms}}{I_{ms}} - \alpha_3 X_{ms}^C\right) - \left(\alpha_{2i} F_{ims}\right)^2 L_s}{\theta^Q \beta_1 \frac{I_{ms}}{Q_{ms}} \left(2 + I_{ms} \theta^Q \left(\frac{\phi R_s}{Q_{ms}} - \frac{1}{I_{ms}}\right)\right) - \alpha_1} \right. \\ & \left. - \alpha_{2i} F_{ims} \frac{Q_{ms}}{I_{ms}} \right] + \theta^L \phi N_s R_s (\delta_0 + \delta_1 X_s^P) - 1. \quad (16) \end{aligned}$$

[31] Note that, although marginal costs are now a firm-specific function, the aggregation of the quantity relation to the market level does not require symmetry regarding production. This is due to the linearity of $C_i(\cdot)$ in Q_{ims}.

C Tables

Table 1. Definition of Variables

Variables	Definition
P	Monthly bill for 500 minutes usage (assuming consumers chose the least expensive plan)[1)]
Q	Quantity proxy: Total number of cells in a given network[1)]
TIME	Time trend in months[1)]
POP	Market (MSA) Population in million inhabitants[1)]
INCOME	Market (MSA) annual income per capita in 10.000 $[1)]
DENSITY	Market (MSA) population density in 100 people per square mile[1)]
BUSINESS	Number of high-potential business establishments (business, health care, professional and legal services, contract construction, transportation, finance,insurance,real estate) divided by 1000 [1)]
ENERGY	Average monthly cost per square foot of office space (in $)[1)]
PRIME	One period lagged prime lending rate[1)]
WAGE	Average weekly salary per employee for the cellular industry (in 100 $)[1)]
RENT	Average monthly rent per square foot of office space[1)]
OPERATE	Average monthly general overhead and operating expenses per square foot of office space[1)]
ENTRY	Dummy=1 after the second carrier enters into the market[1)]
SFIRMS	Number of firms operating in state s at time t[1)]
PRICECAP	Dummy=1 if price cap regulation, profit regulation, or tariff filing requirements applied to the mobile telecommunications industry in a state [2)]
GOVDEM	Dummy=1 if the state's Governor was from the democratic party[3)]
GSALARY	Governor's annual salary in 10.000 $ [3)]
PRESELECT	Dummy = 1 if year of presidential election[3)]
LEGISLELECT	Percentage of the state's legislature that was up for election in a given year[3)]
FEDELECT	Dummy = 1 if year of federal election (Senate and House)[3)]
TIGHT	Absolute value of the % difference between Republicans' and Democrats' seats in the state's legislature[3)]
PUCMEM	Number of members in the State Public Utility Commission (PUC)[3)]
PUCTERM	Length of term of the PUC members (years)[3)]
PUCSTAFF	Number of full-time employees in the State Public Utility Commission[3)]
PUCSAL	PUC members' annual salary in 10.000 $ [3)]
POPSTATE	State population in million inhabitants [3)]
INCSTATE	State annual income per capita in 10.000 $ [3)]
LOBBY	Total industry annual campaign contributions in 10.000 $ (without AT&T)[4)]

Sources: 1) Parker-Röller, 1997; 2) Shew, 1994; 3) The Book of States, The U.S. Statistical Abstract; 4) Center of Responsive Politics

Table 2. Preliminary Statistics - Market Variables

	Full sample		Aggregated sample	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
p	1.972	0.393	1.952	0.400
Q	15.665	17.346	15.097	16.976
TIME	49.240	12.342	51.309	13.879
POP	0.186	0.266	0.172	0.251
INCOME	2.825	0.375	2.809	0.371
DENSITY	0.502	0.398	0.479	0.372
BUSINESS	2.247	0.413	2.226	0.426
ENERGY	1.760	0.372	1.764	0.376
PRIME	9.456	1.107	9.363	1.150
WAGE	5.197	1.285	5.239	1.342
RENT	16.247	4.904	16.526	4.884
OPERATE	6.704	1.683	6.622	1.688
ENTRY	0.680	0.467	0.699	0.449
Observations	478		288	

Table 3. Preliminary Statistics - Political Variables

Variable	Mean	Std. Dev.
GOVDEM	0.619	0.487
GSALARY	7.275	1.689
LEGDEM	0.650	0.478
PRESELECT	0.250	0.434
LEGISLELECT	0.385	0.417
FEDELECT	0.500	0.502
TIGHT	0.315	0.236
PUCMEM	3.988	1.336
PUCTERM	5.456	1.181
PUCSTAFF	2.093	2.012
PUCSALARY	5.549	1.347
ELECT	0.200	0.401
POPSTATE	0.562	0.533
INCSTATE	1.309	0.251
LOBBY	3.150	2.881
PRICECAP	0.415	0.494
Observations	160	

Table 4. Estimation Results

With Controls for PUC Characteristics

	Estimate	**Std.Dev**	**T-value**
$\widehat{\alpha}_0$_CONST	1.3463	0.0865	15.56
$\widehat{\alpha}_1$_QUANTITY	0.0234	0.0015	15.48
$\widehat{\alpha}_2$_LOBBYING	-0.0762	0.0063	-12.03
$\widehat{\alpha}_3$_WAGE	0.0379	0.0124	3.05
$\widehat{\alpha}_3$_RENT	0.0104	0.0033	3.18
$\widehat{\alpha}_3$_YEAR	0.1134	0.019	5.97
$\widehat{\beta}_0$_CONST	1.4715	0.1472	10.00
$\widehat{\beta}_1$_QUANTITY	-0.2460	0.0329	-7.47
$\widehat{\beta}_2$_POP	0.7672	0.1077	7.12
$\widehat{\beta}_2$_BUSINESS	0.0818	0.0386	2.12
$\widehat{\beta}_2$_INCOME	0.1810	0.0504	3.59
$\widehat{\beta}_2$_DENSITY	0.2747	0.0630	4.36
$\widehat{\beta}_2$_YEAR	0.0404	0.0167	2.43
$\widehat{\delta}_0$_CONST	0.3646	0.2149	1.70
$\widehat{\delta}_1$_PUCMEM	-0.0395	0.0255	-1.55
$\widehat{\delta}_1$_PUCTERM	0.0563	0.0306	1.84
$\widehat{\delta}_1$_PUCSTAFF	-0.0501	0.0183	-2.74
$\widehat{\delta}_1$_PUCSAL	-0.0535	0.0312	-1.71
$\widehat{\theta}^Q$	0.4181	0.0572	7.31
$\widehat{\theta}^L$	0.5267	0.0744	7.08
$\widehat{\phi}$	2.3635	0.7123	3.32
Log-Likelihood		-930.56	

Table 5. Estimation Results

With Controls for State Characteristics

	Estimate	**Std.Dev**	**T-value**
$\widehat{\alpha}_0$_CONST	1.3590	0.0860	15.79
$\widehat{\alpha}_1$_QUANTITY	0.0235	0.0015	15.31
$\widehat{\alpha}_2$_LOBBYING	-0.0767	0.0064	-11.99
$\widehat{\alpha}_3$_WAGE	0.0383	0.0124	3.08
$\widehat{\alpha}_3$_RENT	0.0092	0.0033	2.79
$\widehat{\alpha}_3$_YEAR	0.1149	0.0192	5.97
$\widehat{\beta}_0$_CONST	1.4755	0.1474	10.01
$\widehat{\beta}_1$_QUANTITY	-0.2461	0.0331	-7.43
$\widehat{\beta}_2$_POP	0.7649	0.108	7.08
$\widehat{\beta}_2$_BUSINESS	0.0813	0.0388	2.10
$\widehat{\beta}_2$_INCOMES	0.1803	0.0504	3.58
$\widehat{\beta}_2$_DENSITYS	0.2724	0.0631	4.32
$\widehat{\beta}_2$_YEAR	0.0405	0.0167	2.43
$\widehat{\delta}_0$_CONST	0.4220	0.2359	1.79
$\widehat{\delta}_1$_GOVDEM	0.0120	0.0737	0.16
$\widehat{\delta}_1$_GSALARY	0.0270	0.0303	0.89
$\widehat{\delta}_1$_POP_STATE	-0.1862	0.0711	-2.62
$\widehat{\delta}_1$_INC_STATE	-0.3356	0.1641	-2.04
$\widehat{\delta}_1$_TIGHT	0.0686	0.1660	0.41
$\widehat{\delta}_1$_FEDELECT	-0.0372	0.0586	-0.63
$\widehat{\theta}^Q$	0.4249	0.0581	7.31
$\widehat{\theta}^L$	0.5203	0.0727	7.16
$\widehat{\phi}$	2.3107	0.7115	3.25
Log-Likelihood		-926.6	

Table 6. Firm-Specific Cost Advantages Through Lobbying

Firm	Estimate	Std.Dev.	T-value
(12 categories of firms)			
Contel Cellular**	-0.0073	0.0200	-0.34
GTE Mobilnet**	-0.0261	0.0079	-3.32
McCaw Communications**	-0.0463	0.0066	-6.99
US West Cellular*	-0.1487	0.0126	-11.83
Century Cellular**	-0.1427	0.0144	-9.92
PacTel Mobile Access*	-0.0366	0.0095	-3.84
SouthWest Bell Mobile*	-0.1266	0.0122	-10.4
Ameritech Mobile*	-0.1122	0.0129	-8.73
Bell Atlantic Mobile*	-0.0899	0.0154	-5.85
Nynex Mobile*	-0.1234	0.0166	-7.45
BellSouth Mobility*	-0.1234	0.0102	-12.11
Others (small)	-0.0581	0.0056	-10.29
(3 categories of firms)			
BELL*	-0.0942	0.0070	-13.36
IND**	-0.0509	0.0057	-8.88
Others (small)	-0.0609	0.0067	-9.12

*Bell companies (BELL).

**Independent operators (IND).

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