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**Who Decides to Regulate? Lobbying
Activity in the U.S. Cellular Industry**

Tomaso Duso

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Wissenschaftszentrum Berlin für Sozialforschung gGmbH,
Reichpietschufer 50, 10785 Berlin, Tel. (030) 2 54 91 - 0

ABSTRACT

Who Decides to Regulate? Lobbying Activity in the U.S. Cellular Industry

by Tomaso Duso*

How does the choice to regulate a market take place? And how does regulation influence market outcome? We argue that to explicitly model the *simultaneity* between these two issues makes a qualitative difference in the analysis of the role of regulation, and empirically test our model in the U.S. mobile telecommunications industry. We find support for our approach: Regulatory choice should be considered endogenous. We show that, correcting for the simultaneity, regulation's overall effect should have been a reduction of cellular tariffs. However, this result is not highly significant. Our explanation for this finding is that firms' lobbying activity on regulatory choice has been successful: some firms were able to avoid regulation in those market where it would have significantly reduced prices. We argue that this is the real source of the found simultaneity. Moreover, we provide evidence that the probability of regulation was higher, other things equal, when the regulator was appointed by politicians, when the State's Governor came from the democratic party, and when the government was politically stable.

Keywords: Price Regulation, Lobbying Activity, Mobile Telecommunications, Simultaneity Bias, Endogenous Switching Regression, U.S.

JEL classification: C34, C35, D43, L13, L43, L96

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ZUSAMMENFASSUNG

Wer entscheidet zu regulieren? *Lobbying*-Aktivität in der U.S.-amerikanischen Mobilfunk-Industrie

In diesem Beitrag wird explizit berücksichtigt und modelliert, daß die Unternehmen durch ihr Marktverhalten die Regulierungsentscheidung der Aufsichtsbehörde beeinflussen können. Anhand von U.S.-amerikanischen Daten für die Mobilfunk-Industrie (1984-1988) kann die Hypothese, daß die Regulierungsentscheidung endogen durch das Verhalten der Unternehmen am Markt mitbestimmt wird, nicht verworfen werden. Bei Berücksichtigung dieser Simultaneität können wir im Gegensatz zur vorherigen Analysen zeigen, daß die Regulierung die Mobilfunktarife durchschnittlich gesenkt hat. Jedoch ist dieses Ergebnis nur von geringer statistischer Signifikanz. Dieses Phänomen läßt sich durch die Theorie des Lobbying erklären. Bewirkt Regulierung große Preissenkungen, so haben die Unternehmen einen großen Anreiz durch Lobbying eine Regulierung der Mobilfunktarife abzuwehren; mit der Wirkung, daß seltener reguliert wird. Sind die Wirkungen der Regulierung hingegen gering, so sind auch die Lobbying-Anreize klein, und Regulierung wird häufiger beobachtet. Die empirische Analyse zeigt, daß das Lobbying mancher Unternehmen erfolgreich war so, daß gerade solche Märkte nicht reguliert wurden, in den die Regulierung am effektivsten gewesen wäre. Außerdem zeigt sich, daß die Regulierungswahrscheinlichkeit eines Marktes – *ceteris paribus* - steigt, wenn die Regulierungsbehörde von Politikern einberufen wird, wenn der Gouverneur des Bundestaats der demokratischen Partei angehört und wenn die Regierung politisch stabil ist.

1 Introduction

How does the choice to regulate a market take place? And how does regulation influence market outcome? We believe that the analysis of these issues is qualitatively different, if one takes their *simultaneity* into account, since firms may influence the regulatory regime under which they operate. The approach adopted in this paper is a first step in this direction. We will propose a simple simultaneous model for firms pricing behavior and regulatory choice, which encompasses both economic and political factors. The study has different aims. First we want to make a methodological point and prove our conjecture that to analyze the impact of regulation on prices, regulatory choice must be considered endogenous rather than exogenous as previous studies assumed (Shew [1994], Ruiz [1995], Hausman [1995], and Parker and Röller [1997]). Second we want to determine the impact of price regulation on cellular tariffs, taking into account the simultaneity issue. Finally, we want to explain what are the main determinants of regulatory choice, considering some important issues such as the firms' lobbying activity as well as other political factors.

Because of its particular structure, the U.S. cellular telephone industry provides a unique environment to analyze the aforementioned issues. In the early 80's, as this industry began its rapid expansion, many economists and policy makers were somehow skeptical of the benefits of conventional public utility regulation. The regulatory policy towards mobile service then followed a quite unique pattern.¹ The first decision was to split entry and price regulation. Regulatory jurisdiction was assigned to different regulatory agencies: The federal government (Federal Communication Commission, FCC) kept the right to regulate entry through its authority to assign radio spectrum to cellular services providers. The concern according entry policy was with the natural monopoly aspects, which this industry could present. Despite the fact that the magnitude of economies of scale could have been substantial, the final decision of the commission in 1981 was to allow entry of two cellular service providers in each area.² The first ("wireline") license was typically awarded to a regional Bell operating company (the RBOC), which was oper-

¹Shew [1994] provides a very rich overview of the US. Cellular Telephone Industry and of its development.

²The FCC divided the country into nonoverlapping markets corresponding to the 306 Standard Metropolitan and 428 Rural Statistical Areas (SMSAs and SRSAs respectively). In this paper we will concentrate only on the former.

ating in the same area, and the second (“non-wireline” license) was assigned mainly to independent companies. On the other side, price regulation was left to the individual States, because of the service’s local nature. Due to the general skepticism towards traditional public utility regulation, or because of firms’ successful lobbying activity, in only a few States have cellular tariffs been strictly regulated, whereas in others only loosely regulated, and in most they have not been regulated at all. Some States even adopted some form of a regulatory ban, either at the legislative level or at the Public Utility Commission’s (PUC) level. As some authors already noted, this particular regulatory environment provides an exceptional “natural experiment” for a study on the role of regulation on prices as well as of the determinants of regulatory choice. First, one can rule out any entry strategy, given that the entry process is common knowledge and firms in the market are not subjected to the threat of new entry. Second, one can observe many markets where a homogenous product is traded with similar demand and cost characteristics, but where firms are subjected to different regulatory regimes.

Some papers already exist that have analyzed the impact of regulation on the price level in the US cellular industry. They generally tested whether *exogenous* regulatory variables have a significant impact on prices using a reduced form approach.³ The results they obtained are contradictory. Ruiz [1995] found that the regulatory variables did not significantly explain prices, and concluded that the analysis did not allow any policy suggestions. Shew [1994] and Hausman [1995] observed that the regulatory variables were (partially) significant and that the sign of the coefficient was positive. This fact would suggest that prices should have risen from regulation. The main explanation for this finding has been that regulation led to higher prices because it facilitated collusion. The regulatory body, in fact, could have acted as a cartel board which made firms’ pricing strategies common knowledge.⁴ This information dispersion could have made it easier for firms to recognize if someone had chiseled, making collusion easier to sustain. A further analysis of regulation’s effect is presented by Parker and Röller [1997]. They made use of a full specified structural model in order to estimate whether the duopolis-

³Similar analyses were performed for the wireline telecommunications industry as well. See among others Mathios and Rogers [1989], Kaestner and Kahn [1989], Tardiff and Taylor [1993], Blank, Kaserman and Mayo [1995], and also Kriedel, Sappington and Weisman [1996] for a survey.

⁴This kind of explanation can be found in previous works on collusion and price wars in a supergame framework. See Porter [1983a, 1983b].

tic industry structure led to a competitive outcome. Compared to previous works they did not test the impact of exogenous regulation on prices, but rather the impact of exogenous regulation on conduct. The main findings are that substantial collusion was present in the U.S. cellular industry and that regulation played a role in explaining this result.

This kind of approach may be affected -and indeed we will show that it is- by a mis-specification problem.⁵ If regulated firms have some control over the regulatory regime under which they operate, then considering regulatory variables as exogenous may introduce problems of selectivity bias.⁶ One should therefore try to endogenize regulatory choice. There exists some empirical literature dealing with the endogeneity of regulatory decisions. The typical approach is to explain the discrete choice among different regulatory plans using some political and economic factors, which should underlie regulatory policy, as explanatory variables. The regulatory policy in the wireline US telecommunications industry has been empirically analyzed, first in a static and then in a dynamic setting, by Donald and Sappington [1995, 1997]. They found evidence that both the political as well as the regulatory history were the main drivers of the chosen regulatory regime in the different States. Teske [1991], instead, used a rent-seeking argument to answer more clearly the question how firms develop specific political strategies to achieve the desired regulatory environment in the wireline US telecommunications market. In particular he showed that US West, one of the “Baby Bells,” seemed to have adopted the strategy of avoiding regulators, and aggressively influenced legislators in order to achieve the desired deregulation of the markets in which it operated. Yet, all these studies neglect the importance of firms’ strategic behavior in influencing the regulatory game.

The purpose of our paper is to bridge between these two different empirical approaches, accounting for the simultaneity between firms pricing behavior and regulatory decisions. This is not merely a question of proposing a more complex tool in order to enrich the analysis, but rather it is an important qualitative step into the modelling of the political economy of regulation as well as of its impact on market outcome. The environment in which firms operate is not exogenous to them: Firms not only interact with each other in the product market, but they also interact with other subjects, such as the state regulatory decision making, to determine the “world” in which they

⁵See Mathios and Rogers [1989], Donald and Sappington [1995, 1997], and Baron [1995]

⁶Heckman [1976, 1979] is the typical reference for the concept of selectivity bias.

operate. The econometric tool that is appropriate to achieve this goal is an endogenous switching regression model (Maddala and Nelson [1975], Lee [1978, 1979]), which is a simultaneous equations model with a binary qualitative variable (regulatory status) and limited dependent variables (regulated and non-regulated tariffs). There are, thus, several issues that we want to consider in our analysis. First, we want to stress that the right way to study the impact of regulation on prices should be to consider regulatory decisions as *endogenous* rather than as exogenous: the self-selection problem. This presumption can be econometrically tested. We shall show that the correction terms we introduce in the price equation to control for the endogeneity of regulation are highly significant, supporting our presumption that this is an important issue to account for. Second, we want to analyze which impact regulation had on prices. We are then interested to know what would have been the average price in regulated markets, had these markets not been regulated. The typical answer to this question was based on the sign of the exogenous regulatory variables, but this would be incorrect if there is selectivity bias (Kenny et al. [1979]). We shall show that regulated prices are on the average lower than prices one would have expected without regulation, but this finding is not overall strongly statistically significant, particularly in the subsample of regulated markets. Thus, effective regulation does not seem to have had a strong impact on cellular tariffs. On the other hand, we also observe that regulation would have strongly significantly decreased prices, if adopted in those markets which were not regulated. This would suggest that the “wrong” markets were regulated. Our approach is particularly helpful at this point, since it allows us to understand how regulatory decisions were taken and thereby to further explain the previous finding. This is the third aim of our analysis. We observe that some firms have been effective in their lobbying activities, and have achieved a regulatory ban exactly in those markets where regulation would have had the strongest impact in reducing prices. Similar to Teske [1991], also our analysis shows that some firms were better able than others to understand the political environment in which they operated. In some States they could bypass the activity of the less favorable regulator and go directly to the legislator, who might be easier captured and who could decide about a legislative regulatory ban. In others firms could directly influence the regulator and achieve either a regulatory ban by the PUC or particularly favorable regulated tariffs. Finally, in some States firms did not accomplish their rent seeking strategy and consumers’ protection seems to have mainly determined regulatory choices. Furthermore, we controlled

for political factors as well as for regulator's specific characteristics since they are supposed to play a crucial role in the regulatory game. We shall show that, *ceteris paribus*, States where the Governor came from the democratic party and the regulatory commission was appointed by politicians were more favorable to regulation, whereas States where a political change happened in the sample period were more favorable to a form of regulatory ban. The conclusion that we draw from our analysis is that effective regulation seems to have worked in the right direction, but that firms were able to partially avoid its effect achieving, through their lobbying activity, a regulatory ban exactly in those markets where regulation would have had the more visible impact.

The paper proceeds as follows. In Section 2 we give a short description of the market analyzing some preliminary statistics. In Section 3 we derive a theoretical framework which will be our starting point for the empirical analysis. Section 4 deals with the empirical specification and the econometric analysis. We present our main results in Section 5 and close the paper in Section 6 with some concluding remarks.

2 A Short Description of the Market and of the Data

The regulatory environment in the U.S. cellular market is quite unique. The FCC regulated entry, allowing only two firms to operate in every market.⁷ The first license (wireline license) was awarded to a regional Bell operating company beginning in 1981. The second (nonwireline license) was awarded to an independent firm. Reselling of licenses was allowed, the only prohibition being that the same operator may not own both licenses in one area. The process of awarding licenses took several years and some of the nonwireline licenses were resold by firms who won the lottery but were not really inter-

⁷This decision was controversial. FCC's main concern was that of the natural monopoly nature of the industry (this view was also sustained by AT&T), which would suggest to allow only one firm operating in the market. A different approach was proposed by the Antitrust division of the Department of Justice (DOJ), which advocated the awarding of a higher number of licenses (4 or 8). The concern was that, given the uncertainty about the magnitude of economy of scale, there was the risk of allowing too little entry. The main point of the Antitrust Division of the DOJ was that the market should determine the optimal number of firms which can operate efficiently.

ested in operating in the cellular market. The long discussion about how the licences should be awarded and the length of time it took to allocate the licenses,⁸ led to delays in the introduction of cellular services which implied high cost to the U.S. economy.⁹ At the beginning of the 1990's in almost all of the SMSAs two operators were able to offer their services. Regarding the concern about market competitiveness where only two firms operate, the FCC required cellular operators to offer service at wholesale prices also to "resellers". Furthermore it imposed the prohibition of limiting the number of resellers in a market. As Shew [1994] pointed out, the positive effect of reseller competition was limited in many markets.

Even if the entry policy of the FCC raised some doubts in relation to the effective competitiveness, which could be reached in a duopoly market, and even though there were some concerns about the fact that wireline companies had some advantages given by their head-start position, many States decided against the use of price regulation (in Table 1, Column 1 one can see that non-regulated markets are more or less 50% of the sample). Some of the reasons can be found in a general skepticism against price regulation. As well the lack of information about costs was one major problem. A fact which would have made an assessment of proposed prices difficult. Moreover, many policy makers were quite sure that "two is enough for competition," even if warnings about competitiveness, which might be expected from two licences operating in the market, came from many directions. An alternative explanation, which will be the center of our analysis, is that many States adopted some form of regulatory ban, because of the lobbying activity of some firms, whose rent seeking strategy was to avoid a regulated environment. Shew [1994] and Ruiz [1995] provide detailed information about the different regulatory regimes implemented in the individual States. We refer to these papers for a deeper analysis. In our work we will not concentrate on the different forms of regulation. In this first approach we want to test if regulation, in any form, had some clear effect on firms pricing behavior compared to a non-regulation situation, and to investigate what determines the choice for a regulatory ban.¹⁰

⁸Gruber and Verboven [1998] show using OECD data that the role that the timing of the licences played in explaining diffusion of cellular services is significant: states which first granted licences seem to have a fairly long persistent lead.

⁹The cost was estimated to be about 86 billion dollars (Rohlfs, Jackson, and Kelly [1991]).

¹⁰It is worth noting that different regulatory regimes may have different effects on pricing

Our data come from different sources and cover the time spanning December 1984 to July 1988.¹¹ The original data set contains information about service prices, output quantities, input factor prices, demand variables, and industry structure variables. The sample contains information about 122 SMSAs. For our purpose we enlarged the original data set to encompass information about the political and regulatory environment using data from the Statistical Abstract of the United States, and information from the states' regulatory commissions. Table 1 presents the summary statistics for the relevant variables. The first column refers to the full sample, whereas the second and the third refer to the subsamples of non-regulated and regulated markets respectively.¹² In the Appendix we provide a short description of the variables.

[Insert here Table 1]

We can observe that prices in regulated markets are, on the average, slightly higher than in non-regulated markets.¹³ In particular the price p_1 , referring to “low usage” (monthly usage of 5 minutes), is on the average about 7% higher in regulated markets, whereas p_2 (monthly usage of 500 minutes) is around 2% and p_3 (monthly usage of 3000 minutes) 0.5% higher in regulated markets.¹⁴ We don't have firm specific measures of cost, but we can rely on market specific data. One can not observe large differences among regulated and non-regulated markets, even though in the former most

behavior. In this paper we will not consider this issue, even though later we will briefly discuss this point.

¹¹We owe a particular thank to L.H. Röller and P. Parker for providing us with the main data set. A description of the sources as well an analysis of the data can be found in their paper (Parker and Röller [1997]).

¹²Non-regulated markets are those markets where a ban on price regulation was imposed by legislative or regulatory commission action. The regulatory data were courtesely provided by W.B. Shew (see Shew [1994] Table 4.2).

¹³The prices of a singular cellular operator are defined, as in Parker and Röller, as the monthly bill paid for a given level of usage. Normally, cellular operators use nonlinear prices composed by a fixed fee, a usage fee for the “peak hours”, and a usage fee for the “off-peak hours”. Moreover, every operator offers different plans related to the intensity of usage (high, average, or low usage). The prices reported represent the monthly bill calculated for different monthly usage times (5, 500, 3000 minutes) assuming that consumers chose the least expensive plan.

¹⁴Given the high standard deviation, all price differences are not statistically significant.

cost drivers take slightly higher values. Only ENERGY and PRIME are on the average higher in non-regulated markets.

Significant differences can instead be observed with regard to the variable POP. In regulated markets population is on the average much higher (40%) than in non-regulated ones. Also CROSSOWN and MULTIMKT take significantly different values in the two subsamples. In particular both variables assume higher values in non-regulated markets; a fact which could suggest that in those markets collusive behavior was more probable.¹⁵ ENTRY happened slightly more often in regulated markets. We do not observe differences in the number of cellular antennas (N. of CELLS). As Parker and Röller [1997] stressed, the number of cellular antenna sites can be seen as a good proxy for industry output.¹⁶ Finally, as we expected, the State's Governor was more often from the republican party (REP) in non-regulated markets, supporting the hypothesis that republicans are more oriented towards a liberalized industry, whereas in regulated markets the Governors were principally from the democratic party (DEM). Instead, we observe more appointed regulators (APPOINT) in regulated markets than elected ones (ELECT).¹⁷

Concluding, we do not observe strongly significant differences among regulated and non-regulated markets, but we still want to analyze why some markets were regulated and what kind of effects did regulation have.

3 A Theoretical Framework

In this Section we present a theoretical background on which we will base our empirical analysis, and from which we will try to derive some hypotheses to test. It will not be a structural but rather a reduced form model. Despite the fact that this approach has the advantage of being more general, it lacks a rigorous micro foundation.

¹⁵Parker and Röller [1997], in fact, have shown that multimarket contacts and crossownership were among the most important determinants of the industry's collusive conduct.

¹⁶They report a simple Pearson correlation of .9237 (*p-value* < .0001) between cell sites and subscribers at the firm level, and of .9251 (*p-value* < .0001) at the market level.

¹⁷We would have expected to observe higher values for ELECT in the regulated market subsample, under the presumption that elected regulators should be more pro-consumers (see Besley and Coate [2000]) and therefore should regulate more. However, as stressed by Gormley [1981], consumer movements -which should prefer regulation whenever it decreases prices- seem to be more active in state with appointed regulators.

3.1 The Regulatory Choice

As a starting point, we assume that the regulatory agency uses a simple rule to determine whether a market should be regulated or not on the basis of the regulation's effects on prices. Market s will be regulated if:

$$\frac{p_{ts}^{NR} - p_{ts}^R}{p_{ts}^{NR}} > \rho_{ts},$$

where p_{ts}^{NR} and p_{ts}^R are respectively the non-regulated and the regulated price, and ρ_{ts} is a maximal price difference that the regulator would accept. The level of ρ_{ts} should depend on some measures of regulator's specific preferences and on the political environment in which the regulatory agency operates.¹⁸ As a first order approximation we can assume that:

$$\rho_{ts} = \delta_1 RSC_{ts} + \delta_2 PV_{ts} + error\ term_{ts},$$

where RSC is a vector of characteristics specific to the regulator and PV is a vector of political variables.¹⁹ Thus we observe regulation if:

$$\frac{p_{ts}^{NR} - p_{ts}^R}{p_{ts}^{NR}} > \delta_1 RSC_{ts} + \delta_2 PV_{ts} + error\ term_{ts}. \quad (1)$$

We can rewrite equation (1), which constitutes the criterion that determines the regulatory choice, in the form of a probit model. We observe a regulated market ($R_{ts} = 1$) if and only if $R_{ts}^* > 0$ and a non-regulated market otherwise, where:²⁰

$$R_{ts}^* = \alpha_1 \left[\log(p_{ts}^{NR}) - \log(p_{ts}^R) \right] + \alpha_2 RSC_{ts} + \alpha_3 PV_{ts} + \epsilon_{ts}. \quad (2)$$

Now we are able to postulate one general hypothesis, which we want to test in our empirical analysis. If we would assume a benevolent regulator,

¹⁸Ideally the cost of regulation should also be taken into account. Unfortunately it is not an easy task to find a good proxy for it.

¹⁹The only measures for regulator specific characteristics we could use is whether the regulator was appointed by the State's Governor, or directly elected. Basley and Coate [2000] gives a theoretical rationale for the importance of this issue.

²⁰In the empirical analysis we will make use of three different price measures, in order to capture different strategies that firms might have adopted in the different market segments. Accordingly, we will construct three differences between non-regulated and regulated prices that we will use simultaneously as regressor in the probit analysis.

who cares mainly for consumers surplus, then we would expect to observe a significant and positive value for the coefficient α_1 : regulation is more probable when the benefits that it implies in terms of lower prices are larger. This assumption would be in line with a model, which assumes that the regulator takes its choice in order to maximize a weighted sum of consumer and producer surplus.²¹ On the other hand, one can also assume that the regulator is not benevolent and that interest groups, as well as individual firms, can directly influence its decision through lobbying activity. High prices are in the firms' interest. In this case one should then expect a negative coefficient α_1 . This approach would be more in line with the tradition of the "Chicago School", which uses interest group theory to explain regulatory policy.²² The coefficient of the price difference should thus measure the relative weight that the regulator assigns to firms and to consumers lobbying. As Baron [1995, p. 11] pointed out: "The political economy approach is not inconsistent with normative theory, since normative theory should incorporate the political behavior that invariably accompanies policy choice and implementation". Our empirical approach can be seen as a first step in this direction.

In order to explain the different firms' lobbying intensity, we will also allow α_1 to depend on firms specific dummies, that is we will assume:

$$\alpha_1 = f(\text{firm}_{it_s})$$

where firm_{it_s} are dummy variables relative to the RBOCs and to the main independent carriers.

The main problem with the presented approach is that, for each observation, we observe either the regulated price or the non-regulated one, while in (2) we need to compare both prices for every observation. In each regime we need a measure for the price which is not observed. i.e. the price which would have been chosen if the firm had been in the other regime. Our empirical specification will help us to overcome this problem.

3.2 Firms Pricing Behavior

Because prices are endogenously chosen by firms, we also need to model firms' pricing behavior and determine a reduced form price equation. We

²¹This is called the *normative* approach to regulation (see for instance Laffont and Tirole [1993]).

²²This is called the *political economy* approach (see for instance Stigler [1971] and Peltzman [1976]).

will use an approach similar to Kaestner and Kahn [1990] and to Ruiz [1994]. Ruiz developed a supergame framework to determine firms' pricing strategies. He has shown that the monopoly price can be part of a tacitly collusive equilibrium outcome for certain conditions on the discount factor.²³ The cellular price in market s at time t should be such that:

$$p_{ts} = MC_{ts} \cdot \mu_{ts}, \quad (3)$$

where MC_{ts} is the marginal cost and μ_{ts} is the mark-up at time t in market s . We can linearize the previous expression taking logarithms of both sides:

$$\log(p_{ts}) = \log(MC_{ts}) + \log(\mu_{ts}). \quad (4)$$

Since we can not observe marginal costs and mark-up, we need to model them through an equation. We assume that the marginal cost function takes the following form:

$$\log(MC_{ts}) = a_o + a_1 CD_{ts} + a_2 firm_i_{ts} + error\ term_{ts}, \quad (5)$$

where CD is a vector of cost drivers, and $firm_i$ are firms' specific dummies, which should capture the possible heterogeneity in firms' technology. We assume that the mark-up depends on the level of demand (Q) and on vector of market structure variables (MSV) such as multimarket contacts, crossownership, and competitive pressure as generated by the second firm entering the market. We also insert some dummies which account for the status of the wireline/non-wireline pair ($Pair_j_{ts}$), which should capture the argument that some firms' pairs achieve collusive agreements easier than others. We have then:

$$\log(\mu_{ts}) = b_o + b_1 Q_{ts} + b_2 MSV_{ts} + b_3 Pair_j_{ts} + error\ term_{ts}. \quad (6)$$

Since demand is endogenous we also need an equation which explains the demanded quantity:

$$Q_{ts} = c_o + c_1 \log p_{ts} + c_2 DD_{ts} + error\ term_{ts}. \quad (7)$$

where DD are demand drivers. Substituting equations (5), (6), and (7) in equation (4) we obtain a reduced form price equation as follows:

²³Kaestner and Kahn [1990], instead, made use of a conjectural variations argument to come to the same kind of specification.

$$\log p_{ts} = \beta_0 + \beta_1 CD_{ts} + \beta_2 DD_{ts} + \beta_3 MSV_{ts} + \beta_4 firm_i_{ts} + \beta_5 Pair_j_{ts} + u_{ts}, \quad (8)$$

where u_{ts} is an error term. We also expect that regulation might have an impact on firms' pricing behavior, since different regimes should provide cellular operators with different incentives. To account for the fact that the independent variables should have a different impact on prices, depending on which regime prevails, we specify one reduced form price equation for each regime and allow coefficients to differ in the two regimes. Furthermore, the adopted econometric model also involves the use of a correction term in the price equations, which should account for the selectivity bias that arises from the fact of being in one particular regime.

4 Specification and Empirical Implementation

As we mentioned before, regulated firms often have control over the regulatory regimes under which they operate.²⁴ Or, said in another way, there can be simultaneity between the regulatory regime's choice and firms' pricing behavior. We take this issue into account in our empirical analysis, estimating a model of endogenous switching (Maddala and Nelson [1975], Lee [1978]). This is a simultaneous equations model with a binary qualitative variable for the regulatory status and limited (censored) dependent variables: the prices. The empirical implementation of the theoretical framework analyzed in the previous Section implies thus the specification of equation (2), and of two price equations like (8), one for each of the two subsamples:

$$\log p_{ts}^R = \beta_{0R} + \beta_{1R} X_{ts}^R + u_{1ts} \quad (9)$$

$$\log p_{ts}^{NR} = \beta_{0NR} + \beta_{1NR} X_{ts}^{NR} + u_{2ts} \quad (10)$$

$$R_{ts}^* = \alpha_1 (\log p_{ts}^{NR} - \log p_{ts}^R) + \alpha_2 Z_{ts} + \epsilon_{ts} \quad (11)$$

$$R_{ts} = 1 \quad \text{if } R_{ts}^* > 0$$

²⁴See Donald and Sappington [1995, 1997] and Kridel, Sappington, and Weisman [1996].

$$R_{ts} = 0 \quad \text{if } R_{ts}^* \leq 0$$

$$Cov(u_{1ts}, u_{2ts}, \epsilon_{ts}) = \begin{bmatrix} \sigma_{11}^2 & \rho_{12}\sigma_{11}\sigma_{22} & \rho_{1\epsilon}\sigma_{11} \\ & \sigma_{22}^2 & \rho_{2\epsilon}\sigma_{22} \\ & & 1 \end{bmatrix}. \quad (12)$$

Where X_{ts}^r , $r = R, NR$, contains cost drivers (OPERATE, ENERGY, WAGE, RENT, and PRIME) demand drivers (POP and BUSINESS), and a time trend (T) to control for market growth. Furthermore we insert some variables to control for market structure: a dummy equal to one if the second carrier has already entered market s in time t (ENTRY), variables related to cross-ownership and multimarket (CROSSOWN and MULTIMKT), a variable controlling for the monopolist's lead over the second entrant (LEAD), firm specific dummies for the major carriers, and some dummy variables to control for market structure (BELLBELL, INDBELL, and INDIND).²⁵ The vector Z_{ts} contains regulator specific variables (ELECT and APPOINT), as well as political variables (GOVCHANGE and DEM). As already mentioned we assume that the independent variables' coefficients in (9) and (10) are different, allowing complete interaction in the price equations. This assumption, which should capture the different incentives faced by firms in the different regimes, will be tested in the next Section. We assume that the error terms are jointly normal distributed, with a variance-covariance matrix given by (12).²⁶

If one thinks that the selectivity bias problem is not relevant, i.e. that there is no correlation between error terms in the price equations and in the selection equation, then one can consistently estimate the previous model

²⁵According to Parker and Röller [1997] each of these dummy variables (see the Appendix for a definition) "signifies the status of the wireline-nonwireline pair". Note that we don't insert the dummy BELLIND because there is a constant term in our equation. BELLIND represents thus our reference market structure. As well, we eliminate one firm dummy (CENTEL).

²⁶The terms $\rho_{i\epsilon}$ ($i = 1, 2$) represent the correlation coefficient between error terms u_{its} ($i = 1, 2$) and ϵ_{st} . Note that $Cov(u_{its}, \epsilon_{st}) = \sigma_{i\epsilon} = \rho_{i\epsilon}\sigma_{ii}\sigma_{\epsilon} = \rho_{i\epsilon}\sigma_{ii}$ because $\sigma_{\epsilon} = 1$. Note also that the correlation between the error terms of the two price equations (ρ_{12}) is not estimable since each observation comes from one regime. For references see Maddala [1987].

with simple techniques. The two price equations are then separately estimated by OLS, while the equation that explains the choice of price regulation can be estimated by probit. But as Heckman [1976] and others already stressed, if the errors' terms in (9) and (10) are correlated with the error term in (11), then OLS estimates are inconsistent. We can briefly summarize the typical approach. In the selected sample of regulated markets we know that:

$$\begin{aligned}
E[\log p_{ts} | x_{ts}, \text{in sample}] &= E[\log p_{ts} | x_{ts}, R_{ts} = 1] \\
&= \beta'_R x_{Rts} + E[u_{1ts} | \epsilon_{ts} > -\alpha' z_{ts}] \\
&= \beta'_R x_{Rts} + \rho_{1\epsilon} \sigma_{11} [\phi(\alpha' z_{ts}) / \Phi(\alpha' z_{ts})] \\
&= \beta'_R x_{Rts} + \gamma_R \lambda_{1ts}
\end{aligned} \tag{13}$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are respectively the density and the cumulative function of a normal distribution. For the second price equation the same argument in equation (13) applies, though the selectivity term will be different, since we consider the second subsample ($R_{ts} = 0$). Following Lee [1978] we can construct a selectivity bias term for the price equation related to non-regulated markets as follows: $\rho_{2\epsilon} \sigma_{22} [-\phi(\alpha' z_{ts}) / (1 - \Phi(\alpha' z_{ts}))] = \gamma_{NR} \lambda_{2ts}$. The selectivity bias problem arise from the fact that estimating (9) and (10) by OLS one obtains inconsistent coefficient estimates, because $E[u_{its} | \epsilon_{ts} > -\alpha' z_{ts}] \neq 0$ ($i = 1, 2$). To overcome this problem, one can use the endogenous switching regression model (Maddala and Nelson [1975]).²⁷ This can be consistently estimated in two different fashions: either using a two step estimator (Lee [1978]) or using a full information maximum likelihood estimator (Kenny, Lee, Maddala, and Trost [1979]).²⁸ We will use the latter, since it guarantees efficient estimates.

The estimation procedure is as follows. Equation (11) should account for the separation criterium and can be consistently estimated by a probit ML method. Because we do not observe both prices for each observation, in the first stage we estimate a reduced form of the probit equation where we substitute (9) and (10) in (11). Once we get consistent estimates of the α 's, we can

²⁷See also Lee [1978, 1979], Kenny, Lee, Maddala, and Trost [1980], and Maddala [1987] among others.

²⁸Both these estimators present some problems. The two step is inefficient, while the FIML is efficient but ignores the fact that the probit parameters are estimated twice, differently. See Limdep 7.0 Manual page 668. Note also that the FIML estimators allow us to estimate both σ_{ii} and $\rho_{i\epsilon}$ ($i = 1, 2$) in (13), while the two step estimators allows us only to determine the coefficients γ_R and γ_{NR} .

compute $\hat{\lambda}_{1ts} = \phi(\hat{\alpha}'z_{ts}) / \Phi(\hat{\alpha}'z_{ts})$ and $\hat{\lambda}_{2ts} = -\phi(\hat{\alpha}'z_{ts}) / (1 - \Phi(\hat{\alpha}'z_{ts}))$, using the estimated parameters' values instead of the real ones. Then we can consistently estimate the β 's by simultaneously estimating (11), (9) and (10) by FIML after inserting the selectivity bias term as a control in the pricing schedules. The last step consists of estimating the structural probit where we insert the estimated prices instead of the real values.

The typical test of selectivity bias is to analyze whether the coefficients of λ_{its} ($i = 1, 2$) are significantly different from zero. But from the sign and size of the coefficient estimates we can learn even more, namely how the selectivity terms influence pricing behavior, since they represent the covariance between the error terms of the price equations and of the separation criterion. As Maddala [1987] has pointed out, “[...] we ought to observe $\sigma_{2\epsilon} - \sigma_{1\epsilon} > 0$, but the two covariances can have any sign. It is also important to estimate the mean values of the dependent variable for the alternative choices.” In our model this would mean estimating the price in regulated markets had they not been regulated and vice versa. In this way we can determine regulation's effects on prices.

To summarize, the questions we want to address with our empirical analysis are the following: (i) Is there selectivity bias? (ii) Do the explanatory variables in different regimes have different effects on the dependent variable? (iii) Does regulation imply higher or lower prices? (iv) Which markets are regulated? (v) Why is a market regulated?

5 Results and Interpretation

In this Section we report our main results. First we replicate previous analyses by running simple OLS regressions of the reduced form price equation on the full sample using exogenous regulation dummies, and on the two subsamples of regulated and non-regulated markets. Then we assess the selection problem and the simultaneity problem estimating the endogenous switching regression model discussed in the previous Section. To enrich our analysis, and to observe whether regulation had different effects on different cellular tariffs, we will propose different specifications in which we use as dependent variable the three measures of prices which are available to us.

5.1 The Simple OLS Estimates

In order to obtain some first results to compare with previous analyses, we run a simple OLS regression of the reduced form price equation. These preliminary results are also useful in order to obtain a starting point for understanding the role of selection bias. In Table 2.1 we adopt a specification which makes use of an exogenous regulatory dummy among the independent variables. We analyze three cases corresponding to the three different dependent variables: the logarithm of the price for low, middle, and high usage time. The main finding is that only the low usage price is significantly and positively dependent on the regulatory dummy. In this case we observe a result similar to Shew [1994] and Hausman [1995]: regulation seems to have increased cellular prices. On the other side this result does not hold for the other two price measures (middle and high usage time). In those cases in fact, the regulatory dummy is not significant, which is more in line with Ruiz's [1995] findings.

Many of the other independent variables are significant in the three specifications, however one can note some differences in their effects on the different cellular tariffs. The cost drivers are generally positive, as expected, except ENERGY which is significant and negative in all specifications. In the second and third specifications POP presents a positive and significant coefficient estimate, while in the first the coefficient estimate is not significant, although positive. The cost of cellular service should be higher when population is greater because of economies of scale in supplying cellular services. In the case of high usage tariffs one observes a significant and negative coefficient for BUSINESS. This variable is not significant in the second specification and it is positive and significant in the third. The time trend (T) is negative and strongly significant in all specifications as expected: the market growth generated downward pressure on prices.²⁹ This effect was stronger for low usage time tariffs.

[Insert here Table 2.1]

The most unexpected results are those related to the market structure variables. Only in the first specification are the coefficients of CROSSOWN

²⁹This is because one should expect demand to expand and to become more price elastic with time.

and MULTIMKT significant. Furthermore, the former of the two variables present the negative sign, which was not expected. The other two price measures don't seem to be significantly influenced by multimarket contacts and by crossownership. Also the competitive pressure generated by the entrant firm (ENTRY) does not seem to have had a strong impact, especially on middle and high usage time prices. Instead, it had a significant effect in reducing low usage tariffs as expected.³⁰ The dummies relative to the wireline-nonwireline pairs and the firms specific dummies are partially significant, but present different signs and significance levels in the different specifications. Again the main differences can be observed in relation to the first specification, whereas the second and third show more similar results. Finally, firm specific dummies are in all specifications highly significant.

It is also interesting to run the OLS regression on the two subsamples of regulated and non-regulated markets to investigate whether coefficient estimates are equal for the two subgroups (Table 2.2).³¹ The coefficients' size and significance differ strongly in the two subsamples: many variables are significant only in one specification and some variables have even the opposite sign.³²

[Insert here Table 2.2]

In particular one can observe that cost and demand drivers are significant mainly in the regulated markets' subsample, while in non-regulated markets firm specific effects are the main price determinants.³³ One possible explanation for this result is that these are the variables on which a benevolent regulator should have based regulated tariff, since they should explain

³⁰This fact can suggest that this market segment was more competitive than others, also given the negative, significant and larger coefficient estimates for the time trend (T). It may then be that regulation wouldn't have been necessary in this segment, but rather that it had a negative impact on the degree of competition.

³¹The dependent variable is in this case $\log(p2)$. We report only this result for a matter of space. Anyway, as Parker and Röller [1997] stressed, operators refer to this usage as the *typical* cellular subscriber's usage time.

³²If the coefficient estimates were really different in the two regimes, it would mean that there is some interaction between the explanatory variables and the fact of being in a regulated or in a non-regulated market.

³³Except for GTE and REST all firms' dummies are significant at the 1% level in the non-regulated markets subsample, whereas only NYNEX is significant in the other subsample.

consumer surplus. Firm specific terms, instead, played a more central role in non-regulated markets. Later we will come back to this point when we discuss the results of the endogenous switching model.

To conclude this preliminary analysis, the regularities we observed using this simple approach suggest that firms used different strategies in the different market segments as expressed by the different cellular price measures. Furthermore, the effect of regulation on prices is not clear: on the one side the regulatory dummy is significant only in one specification, on the other side we observe that in the two subsamples of regulated and non-regulated markets independent variables had strongly different effects on cellular prices, suggesting that regulation did influence firms' strategic behavior. Our more sophisticated approach should help us to derive clearer results.

5.2 The Endogenous Switching Model

In this section we analyze the results of the full information ML estimation of the switching regression model presented in Section 4. We first present the result concerning the two pricing relations. Table 3.1 reports the coefficient estimates for the reduced form price equation in the subsample of regulated markets and presents three different specifications depending on the adopted price measure. Table 3.2 reports the results relative to the non-regulated markets.

[Insert here Table 3.1]

Before analyzing in detail the coefficient estimates for the other dependent variables, we want to observe the role of selectivity bias in both subsamples, since this is one of the main points of our analysis. With respect to the simple OLS regression, we have one more regressor which has to account for the self selection. Its coefficient is given by the product between $\rho_{i\epsilon}$ and σ_{ii} , $i = 1, 2$. In the regulated markets' subsample both $\rho_{1\epsilon}$ and σ_{11} are strongly statistically significant. Also in non-regulated markets the coefficient of the selectivity bias correction are highly significant. Both $\rho_{2\epsilon}$ and σ_{22} are strongly statistically significant in the first specification, while only the variance σ_{22} is significant in the second and third ones. The strong significance of these terms in both subsamples and in all specifications is the first compelling result of our analysis: regulatory choice has to be considered endogenous.

The price estimate we would obtain without correcting for selectivity bias would in fact be inconsistent and biased.

[Insert here Table 3.2]

Now we turn to a more detailed description of the regression results relative to firms' pricing behavior. We start with the regulated markets' subsample (Table 3.1). The results reflect many of the findings that we observed with the simple OLS regression. First, there are evident differences in pricing behavior among low usage time tariffs on the one side and middle and high usage time tariffs on the other.³⁴ Second, similar to the results observed in Table 2, the only determinants of regulated prices, a part of the selectivity bias term, are some demand and costs drivers. Firm specific terms and market structure variables are not significant at all in the second and third specification: regulated prices are not set by firms rather by the regulator.

Also in the non-regulated markets' subsample we observe strong differences among the first specification on the one hand and the second and third on the other. In this case we observe that prices hardly depend on demand and costs drivers, but are very significantly dependent on firm specific effects. Not only are the firms' dummies very significant, but also the wireline/ non-wireline pairs dummies.³⁵ In particular it seems that markets, where an independent carrier owned the wireline license, were more competitive in the sense that prices were lower with respect to the reference group, which includes the BELLIND pair. The presence of two baby Bells in the same market seems instead to have increased prices. It also seems that most firms set prices more aggressively than the excluded CENTEL.

A last minor but interesting comment may be done with regard to the entry policy. Competitive pressure imposed by the second firm entering the market did not push prices downwards, at least not middle and high usage time tariffs. Thus, it might have been possible that the entry of more firms

³⁴This is not surprising. The sample period corresponds to the very early phase of cellular telecommunications in the US. In that period most of the customers were business people who probably preferred higher usage times. Firms' pricing behavior, thus, is likely to have followed different paths in the different market segments.

³⁵The most of firms' specific dummies are significant (BELLSTH, AMERTECH, US WEST, SWBELL, and MCCA); only NY NEX, GTE, CONTEL and REST are not significant. REST contains also PACTEL.

could have had a more visible impact on reducing prices. This would suggest that the proposal of the DOJ's Antitrust Division for a less restrictive entry regulation could have led to a more competitive industry structure than under the achieved duopolistic competition.

Before moving to the direct analysis of the effect that price regulation had on tariffs, we want to statistically test whether coefficient estimates differ among the two subsamples using a Wald test.³⁶ We strongly reject the hypothesis that the same coefficients apply to the two subgroups for all specifications at any usual confidence level. This means that the explanatory variables in the two subgroups have different effects on the firms' pricing strategy, since they interact with the fact of being regulated or not: firms' behavior is influenced by price regulation.

Previous studies suggested that regulation should have increased cellular tariffs, since the regulatory dummies have a positive impact on price. Our OLS regressions partially confirmed this result, at least for low usage fees. To assess more directly the regulation's impact on price, we can ask which would have been the price in regulated markets, had these markets not been regulated. We must then determine $E[\log p_{ts}^{NR} | R_{ts} = 1]$. Observe that:

$$\begin{aligned} E[\log p_{ts}^{NR} | R_{ts} = 1] &= E[\log p_{ts}^{NR} | R_{ts}^* > 0] \\ &= \beta'_{NR} x_{Rts} + E[u_{2ts} | \epsilon_{ts} > -\alpha' z_{ts}] \\ &= \beta'_{NR} x_{Rts} + \rho_{2\epsilon} \sigma_{22} [\phi(\alpha' z_{ts}) / \Phi(\alpha' z_{ts})] \end{aligned}$$

We can now use the consistent estimates of β'_R , β'_{NR} , $\rho_{i\epsilon}$, and σ_{ii} , $i = 1, 2$, and determine the predicted prices with and without regulation for the subsample of regulated markets. Table 4.1. reports the summary statistics for the predicted prices in regulated markets (\hat{p}^R), in regulated markets had they not been regulated (\hat{p}^{NR}), and for the difference between the two. The predicted prices with regulation are on the average lower than the predicted prices without regulation in the second and third specification, while higher in the first. This would mean that (on the average) regulation has substantially decreased middle and high usage time prices and increased low usage tariffs. This would partially reverse the results obtained in the literature with dummy variables models. However, we can also note that the standard deviation of the difference between the two prices is very large. Hence, to reach a more

³⁶We compute the statistic $W = (\hat{\beta}_{NR} - \hat{\beta}_R)' [Var(\hat{\beta}_{NR}) + Var(\hat{\beta}_R)]^{-1} (\hat{\beta}_{NR} - \hat{\beta}_R)$ which is distributed as a chi-squared with J degrees of freedom, where J is the number of restrictions we are testing (in our case 27). See Green [1993].

robust conclusion, we can make use of a more precise statistical analysis and test the null hypothesis $\hat{p}^R = \hat{p}_R^{NR}$. This is a simple statistical test and we can not accept the null hypothesis at any usual confidence level for any of the used price measures.

**Table 4. Predicted Prices With and Without Regulation:
Regulated Markets**

	Low Usage Time	Middle Usage Time	High Usage Time
\hat{p}^R	16.5986 (10.9783)	196.5143 (32.0725)	1022.5531 (169.0044)
\hat{p}_R^{NR}	15.1156 (5.7072)	219.8076 (71.0541)	1180.4176 (421.2151)
$\hat{p}_R^{NR} - \hat{p}^R$	-1.4831 (12.6154)	23.2934 (69.3374)	157.8645 (417.6180)

Standard errors in parenthesis

Predicted prices in regulated markets, had these markets not been regulated, are on the average different than regulated prices but not significantly. This finding would then mean that regulation, where it was applied, did not have very evident effects in reducing prices: in some markets it was effective, in other not. Yet, one main simplifying assumption for our approach is to consider regulation as a single entity. This need not be the case. As we already mentioned regulatory plans vary widely in the different States. Furthermore, it is also not clear to what extent the regime, which is “formally” chosen, is also implemented, especially due to problems such as asymmetric information about firms’ costs. That is to say that there is much heterogeneity in regulatory decisions, which is not encompassed in our approach and which could be an important element to explain the observed result that effective regulation did not have a strong impact on prices.³⁷

³⁷A possible extension of our model, which would take this issue into account, could be to use a nested logit approach to explain regulatory choice instead of the simple probit analysis as we did. This would allow us to consider that, once the regulator has chosen to regulate, it must also choose which kind of regulation to apply. In this way we would be able to account for the different regulatory choices that the authority has to take.

We can also do the same exercise for non-regulated markets and ask what would have been the price had they been regulated (\hat{p}_{NR}^R).³⁸ In Table 5 we report our results. Predicted prices in non-regulated markets, had regulation occurred, would have been lower than predicted prices without regulation in the second (-6.10%) and third specification (-10.67%) but much higher in the first (+49.94%). Again the standard deviation of the difference between the two prices is large. We can again perform a simple test of the null hypothesis $\hat{p}_{NR}^R = \hat{p}^{NR}$.

**Table 5. Predicted Prices with and without Regulation:
Non-Regulated Markets**

	Low Usage Time	Middle Usage Time	High Usage Time
\hat{p}^{NR}	11.9414 (4.5836)	208.7726 (32.6688)	1126.0728 (191.1669)
\hat{p}_{NR}^R	17.5177 (8.5838)	196.0327 (31.7634)	1005.9487 (171.3675)
$\hat{p}_{NR}^R - \hat{p}^{NR}$	5.5763 (5.3633)	-12.7398* (8.2788)	-120.1241* (76.0111)

Standard errors in parenthesis

* represents significance at the 10% level

In this case we can accept the null hypothesis at the 10% confidence level for middle and high usage tariffs, but not for low usage ones.³⁹ This means that regulation would have significantly decreased prices for those customers who made extensive use of cellular services in non-regulated markets. The second line of Figure 1 represents the sample distribution for the price difference in the non-regulated markets' subsample. The positive effects, which

³⁸We calculate $E[p_{ts}^R | R_{ts} = 0] = \beta'_R X_{NRts} + \sigma_{1\epsilon} \sigma_{11} [-\phi(\alpha' z_{ts}) / (1 - \Phi(\alpha' z_{ts}))]$.

³⁹At this point, note the importance of the selection bias. From our simple OLS regression we would have concluded that regulation has *significantly* increased low usage tariffs, while it did not have any significant impact on the other two price measures. With our more complex approach, instead, we obtain evidence that regulation would have significantly (even though only partially) decreased middle and high usage tariffs, while the positive impact on low usage prices is not observed to be significant.

regulation would have had, are clear to see. There is no observation above the zero line: in all markets prices would have fallen.⁴⁰

Summarizing, we observed that regulation was not very effective in reducing cellular tariffs in regulated markets, and it even had negative effects on some price measures as previous analyses observed. On the other hand it seems that cellular tariffs would have significantly fallen if regulation would have been adopted in non-regulated markets: were the “wrong” markets regulated?

Table 6. Structural Probit: The Probability of Regulation

Variables	Coeff.		St.Er.
$\log p1_{ts}^{NR} - \log p1_{ts}^R$	0.143	**	0.70E-01
$\log p2_{ts}^{NR} - \log p2_{ts}^R$	4.624	***	1.058
$\log p3_{ts}^{NR} - \log p3_{ts}^R$	-4.796	***	0.927
DEM	1.391	***	0.205
GOVCHANGE	-1.392	***	0.279
ELECT	0.24E-01		0.161
APPOINT	0.467	***	0.139
Log likelihood			-326.052
Chi squared			93.2469
Obs.			538
Correct Predictions			60.59%

*** represents significance at the 1% level

To answer this question we perform the structural probit analysis, where we insert as a regressor the difference between predicted prices without and with regulation, as we derived in the previous Section. Also, since we think that the three prices can represent firms’ strategies in different market segments, we use the three derived differences simultaneously as regressors in the probit equation. As we already noted, the coefficient of the difference between the prices should help us to distinguish between two effects: firms

⁴⁰The opposite can be observed for low usage prices. However in this case the distribution is much more flattened near to zero (Skewness’ measure= -1.4799 and Kurtosis’ measure= 6.3462), which should explain the reason for the rejection of the null hypothesis.

lobbying activity, which would imply a negative coefficient; and consumers' protection, which would instead imply a positive coefficient. This is true only if regulation decreased prices. In the previous Section we observed that regulation seems to have decreased middle and high usage tariffs, while increasing low usage tariffs. Therefore a coefficient with a positive sign for the first difference could also be interpreted as a sign that lobbying activity was successful, since firms achieved to be regulated in markets where regulation would have increased tariffs.⁴¹

The results we obtain are helpful to clarify the previous findings. Both consumers' protection and firms' lobbying activity seems to have played a role on the choice of regulatory regime, since the first and second price difference present a positive sign, while the third presents a negative one. This would suggest that firms concentrated their rent seeking strategies in those markets where regulation would have hurt more, i.e. those markets where most of the customers were long-time cellular services users.⁴² From the previous results, in fact, we know that regulation would have strongly and significantly decreased exactly those prices. Moreover, it is worth noting that the sample period we are considering corresponds to the very early phase of the US cellular industry. In that period the main market segment was constituted by business customers, who probably made extensive use of cellular services. One can not say much concerning the magnitude of the coefficients' estimates, which are evaluated at the overall means of the data set. This is because the probit model is a non linear model, and the magnitude of the effect of exogenous variables on the dependent variable varies with the values of the exogenous variables.⁴³

Turning to the other explanatory variables we can observe that they are all highly significant. If the State Governor in the second half of the sample period came from the democratic party, the probability to observe price regulation was higher. This result was somehow expected, given that the

⁴¹Unfortunately our approach does not allow us to fully distinguish among the different regulatory decisions, and consequently firms' lobbying strategies. One should in fact model both choices that the regulatory commission must take: whether to regulate, and the decision about price levels.

⁴²This finding is also consistent with the fact that the regulator might have concentrated its action in those markets where final consumers -and not intermediate customers such as business people- were more important. This is suggested by the positive sign of the second difference.

⁴³As pointed out by Aldrich and Nelson [1984] "The sign of the coefficient determines the direction of the effect and the effect tends to be larger, the larger is the coefficient."

democratic party is supposed to pursue a more consumers-oriented policy. On the other side the probability of regulation was lower in States, which experienced a political change during the sample period. This fact might reflect the idea that States in which political changes occurred were more open to a more innovative regulatory policy, such as full price liberalization. Finally, we observe that appointed regulators increased the probability of regulation, if compared to an elected ones. Given the theoretical and empirical findings by Besley and Coate [2000], we would have expected the opposite result, since elected regulators are supposed to be more pro-consumer, and therefore should more often adopt regulation, given that it seems to reduce prices.⁴⁴ On the other side, Donald and Sappington [1997] and Teske [1991] did not find any evidence of the fact that elected regulators had an influence on regulatory decisions.

This version of our model generates correct predictions for the probability of regulation in 60.59% of the analyzed cases.

[Insert here Table 7]

Before concluding we also tested whether lobbying intensity was different across firms. To do this we made the coefficient of the price difference dependent on firms' specific dummies (Table 7). We can observe that lobbying intensity was different across firms: SOUTHBELL, GTE, CENTEL and minor firms seem to have been more successful in their rent seeking strategy.⁴⁵ Controlling for the effect of individual firms dramatically increases the fit of our model: it generates correct predictions for the probability of regulation in 96.65% of the analyzed cases, that makes us quite confident about its correctness.

⁴⁴One should however take into account that Besley and Coale analysis is of the "exogenous dummies type". This approach, as we have shown, might be affected by a selectivity problem, if the choice to elect or to appoint a regulator is endogenous. Furthermore, in their sample they observe that the number of elected regulators is higher in States with a democratic government. Whereas in our sample (which is much smaller) we observe the contrary. It could then be that their results are biased by the fact that they did not control for political effects.

⁴⁵Note that also PACBELL is now considered among "minor" firms.

6 Conclusions

This paper tried to bridge two different approaches of the empirical literature on regulation, and empirically analyze the simultaneity between the price regulation's choice and firms' pricing behavior. We used data from the U.S. mobile telecommunications industry since it shows a very particular regulatory environment. The industry under consideration is quite homogenous for product characteristics, firms' technology and demand, but at the same time it is heterogenous for the kind of price regulation, which was adopted. Some States adopted strict price regulation, some loose price regulation, and others even banned price regulation. The study had different aims. First we wanted to prove the endogeneity of regulation. Second we wanted to determine the impact of price regulation on cellular tariffs, taking the simultaneity issue into account. Finally, we wanted to explain what are the main determinants of regulatory choice. The econometric method we adopted consists of the estimation of an endogenous switching regression model (Maddala and Nelson [1975], Lee [1978]), which fits the questions we wanted to address, as well as the information contained in our data set. To enrich the analysis we consider three measures for cellular prices, corresponding to different usage times, which allows us to take into account different firms' strategies in the different demand segments.

We have shown that the selectivity bias problem, i.e. the endogeneity of regulation, is an important issue to account for. Simple OLS estimations of the reduced form price equation, which use exogenous dummy variables to explain the role of regulation, would then lead to inconsistent and biased estimates. Controlling for the selectivity bias, we have shown that prices in regulated markets were on the average lower than the prices firms would have set, had these markets not been regulated. But the impact of regulation is not observed to be statistically significant: regulation seems therefore not to have been very effective. On the other hand, however, we observed that prices in non-regulated markets would have significantly fallen if regulation would have been adopted. It seems thus that the wrong markets were regulated. In order to explain this unexpected result we also modeled the regulatory choice, making use of a probit analysis. The equation that we used allowed us to encompass different approaches to regulation, and enable us to analyze whether firms' lobbying activity or consumer protection were the main determinants of the regulatory choice, after controlling for other important factors such as the political environment and regulator specific

characteristics. We provided some robust evidence that, because of firms' lobbying activity, the "wrong" markets were regulated, i.e. those markets where regulation would have significantly decreased prices. Furthermore we can qualify our result. Firms' lobbying activities seem to have been more concentrated in those markets where business customers played a relevant role, since their regulation would have more severely hurt firms. Also, the intensity of the lobbying activities seems to have been different among firms: some firms better understood the environment in which they operated. Finally, we have shown that also regulator's characteristics as well as political variables have very high explanatory power for the regulatory choice. Appointed regulators, *ceteris paribus*, enhanced the probability of regulation more than elected ones. Furthermore, States where the Governor came from the democratic party and whose government was politically stable in the sample period were more favorable to some kinds of price regulation.

We can then conclude that our new approach, which allows a more careful and complete analysis of the studied issues, leads to new results in comparison to those already observed in both streams of the considered literature. We do provide some evidence that price regulation, *per se*, would have worked in the right direction, decreasing cellular tariffs. Effective regulation, though, did not have a strong impact, because of the ability of firms to avoid it in those markets where it would have been more effective. We were thus able to shed new light on the political economy of regulation.

Some major caveat applies to our analysis. First, even though our data set is quite rich, there are still some important facts that have not been considered in the analysis for lack of data. For instance, we do not have any information about the costs of regulation or about more precise regulator's individual characteristics, which might be important determinants of the regulatory choice. Second, we limited our analysis to the dichotomous regulatory choice, not considering that different kinds of price regulation were actually adopted, and that they could have had very different impacts on prices. In particular, this consideration might help to understand more clearly which kinds of regulatory scheme did not work. Regarding this issue we already mentioned one possible extension of our approach in the previous Section. Third, regulatory decisions are not only related to the simple choice whether to regulate a market or not; the regulatory commissions, in fact, must also decide about many other issues, which are likely to have an influence on the choice of whether to regulate or not. These issues could be therefore simultaneously studied in a more general model of regulation, but in this case

new data would be probably necessary. Finally, in this paper we adopted a reduced form approach to the political economy of regulation as well as to firms' strategic behavior, whereas both issues could be approached in a more structural way. In particular, the interaction among regulatory commissions, legislators, and interest groups should be more deeply considered. Hence the results we reported do not have to be considered definitive, even if we believe that they are a first important step into a deeper understanding of the choice of regulation and of the effects of regulation on firms pricing behavior.

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Appendix: Variables Definition

Variables	Definition	Vector	Source
p_1, p_2, p_3	Monthly bill calculated for different monthly usage times (5, 500, 3000 minutes)		Parker-Röller [1997]
ENERGY	Average monthly cost per square foot	CD	Parker-Röller [1997]
PRIME (lagged)	One period lagged prime lending rate		
RENT	Average monthly rent per square foot of office space		
WAGE	Average weekly salary per employee for the cellular industry		
OPERATE	Average monthly general overhead and operating expenses per square foot		
POP	Market Population in millions	DD	
BUSINESS	Number of high potential business establishments (divided by 100)		
T	Time trend in months		
ENTRY	Dummy=1 when the second carrier enters into the market	MSV	
CROSSOWN	Dummy=1 when the two competitors in one market are partner in any other market		
MULTIMKT	Total number of markets where the two competitors face each other		
LEAD	Length of the monopoly period in months		
N.of CELLS	Total number of cells in a given network		
BELLBELL	Dummy=1 if both wireline and nonwireline competitors are RBOCs	$Pair_{ij}$	Parker-Röller [1997]
BELLIND	Dummy=1 if the wireline is a BELL and the non-wireline is an independent carrier		
INDBELL	Dummy=1 if wireline is an independent carrier and the non-wireline is a BELL		
INDIND	Dummy=1 if both wireline and nonwireline competitors are an independent firm		
Firm Dummies	Uwest, Bellsth, Amerrech, Nynex, Swbell, Gte, Conel, Mccaw, Centel, Rest	$Firms_i$	Shew [1994]
REG	Dummy=1 if in the market no regulatory ban was imposed		
DEM	Dummy=1 if the State's Governor in 1986 was from the democratic party	PV	US Statistical abstract
GOVCHANGE	Variable=1 if in both elections in the sample period the Governor came from the democratic party, 0 if he came from the republican party, 0.5 if there was a political change		
ELECT	Dummy=1 if the regulator was elected	RSC	The Book of The States
APPOINT	Dummy=1 if the regulator was appointed by politicians		Besley-Coate [2000]

Tables

Table1. Summary Statistic

Variables	Full sample		Sub-sample Regulation		Sub-sample No Regulation	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
p_1	16.286	12.693	16.865	11.918	15.689	13.440
p_2	196.266	39.4953	198.220	39.932	194.254	39.012
p_3	1029.380	237.4932	1032.091	214.455	1026.590	259.448
ENERGY	1.773	0.435	1.776	0.519	1.779	0.329
PRIME (lagged)	9.513	1.069	9.436	1.086	9.569	1.049
RENT	15.965	4.962	16.900	6.232	15.156	3.076
WAGE	522.630	118.805	527.713	119.349	515.119	118.569
OPERATE	6.682	1.701	6.819	2.152	6.609	1.082
POP	0.187	0.271	0.220	0.360	0.158	0.134
BUSINESS	2251.594	404.481	2219.250	454.855	2290.210	345.356
T	21.438	11.938	21.081	11.896	21.179	12.001
ENTRY	0.741	0.438	0.776	0.418	0.692	0.462
CROSSOWN	0.328	0.470	0.224	0.418	0.447	0.498
MULTIMKT	3.497	2.7721	2.881	1.781	4.241	3.409
LEAD	10.530	7.995	9.910	7.316	11.303	8.666
N. of cells	15.753	17.154	15.936	19.224	15.953	15.322
REG	0.507	0.500	1.000	0.000	0.000	0.000
DEM88	0.547	0.498	0.623	0.486	0.469	0.500
REP88	0.453	0.498	0.377	0.486	0.531	0.500
GOVCHANGE	0.636	0.366	0.635	0.405	0.637	0.321
ELECT	0.190	0.392	0.153	0.361	0.227	0.420
APPOINT	0.810	0.392	0.847	0.361	0.773	0.420
Obs.	554		281		273	

Table 2.1. OLS Estimates - Regulation Dummies

Variables	Low Usage ($\log p_1$)		Middle Usage ($\log p_2$)		High Usage ($\log p_3$)	
	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.
CONSTANT	3.319 ***	0.457	5.123 ***	0.150	6.810 ***	0.173
OPERATE	0.98E-01 ***	0.24E-01	0.50E-02	0.79E-02	0.42E-02	0.91E-02
ENERGY	-0.1349 **	0.64E-01	-0.41E-01 *	0.21E-01	-0.41E-01 **	0.24E-01
WAGE	0.40E-03 **	0.19E-03	-0.54E-05	0.54E-04	0.11E-04	0.62E-04
RENT	-0.76E-02	0.80E-02	0.12E-01 ***	0.26E-02	0.13E-01 ***	0.30E-02
PRIME (lagged)	-0.121 ***	0.33E-01	0.13E-01	0.11E-01	0.20E-01	0.12E-01
POP	0.147	0.124	0.175	0.41E-01	0.165	0.47E-01
BUSINESS	0.14E-03 **	0.64E-04	-0.20E-05	0.21E-04	-0.74E-04 ***	0.24E-04
T	-0.11E-01 ***	0.32E-02	-0.46E-02 ***	0.10E-02	-0.36E-02 ***	0.12E-02
CROSSOWN	-0.168 **	0.85E-01	-0.32E-01	0.28E-01	-0.44E-01	0.32E-01
MULTMKT	0.61E-01 ***	0.17E-01	0.14E-02	0.54E-02	-0.25E-02	0.63E-02
LEAD	0.19E-02	0.36E-02	0.24E-02 **	0.12E-02	0.11E-02	0.14E-02
ENTRY	-0.469 ***	0.89E-01	0.22E-01	0.29E-01	0.56E-01 *	0.33E-01
BELLBELL	-0.565 ***	0.153	0.300 ***	0.50E-01	0.339 ***	0.57E-01
INDBELL	-0.915 ***	0.1521	-0.38E-01	0.50E-01	-0.228 ***	0.57E-01
INDIND	0.76E-01	0.151	-0.118 **	0.49E-01	-0.195 ***	0.57E-01
Firm dummies	***		***		***	
REG	0.107 ***	0.50E-01	0.95E-02	0.16E-01	13E-01	0.19E-01
Adj. R ²	0.5670		0.4313		0.493	

*** ** * represent significance at the 1%, 5%, 10% levels respectively

Table 2.2. OLS Estimates: Different Samples
Dependent Variable $\log(p2)$

	Subsample Regulation			Subsample No Regulation		
	Coeff.		Std.Err.	Coeff.		Std.Err.
CONSTANT	5.191	***	0.253	4.629	***	0.208
OPERATE	0.22E-01	*	0.12E-01	-0.78E-02		0.11E-01
ENERGY	-0.83E-01	**	0.33E-01	0.23E-01		0.37E-01
WAGE	-0.37E-03	**	0.15E-03	0.65E-04		0.53E-04
RENT	0.86E-02	***	0.33E-02	0.28E-02		0.37E-02
PRIME (lagged)	0.30E-02		0.14E-01	0.63E-01	***	0.14E-01
POP	0.137	***	0.47E-01	0.246	**	0.96E-01
BUSINESS	0.11E-03	***	0.30E-04	0.20E-04		0.31E-04
T	-0.61E-02	***	0.14E-02	0.19E-02		0.14E-02
CROSSOWN	-0.56E-01		0.53E-01	0.43E-02		0.32E-01
MULTIMKT	-0.15E-01		0.98E-02	0.48E-02		0.61E-02
LEAD	0.44E-02	***	0.19E-02	0.90E-03		0.16E-02
ENTRY	0.16E-01		0.39E-01	0.20E-01		0.38E-01
BELLBELL	0.168		0.116	0.478	***	0.59E-01
INDBELL	-0.16E-02		0.77E-01	-0.141	**	0.66E-01
INDIND	-0.66E-01		0.111	-0.210	***	0.65E-01
Firm dummies		*			***	
Adj. R ²		0.5127		0.6554		
Obs.		278		270		

***, **, * represent significance at the 1%, 5%, 10% levels respectively

**Table 3.1 FIML Estimates: Price Equation
Regulated Markets**

	Low Usage		Middle Usage		High Usage							
	Coeff.	St.Err.	Coeff.	St.Err.	Coeff.	St.Err.						
CONSTANT	2.664	***	0.760	***	5.132	***	0.421	***	6.719	***	0.440	
OPERATE	0.41E-01		0.41E-01		0.21E-01		0.22E-01		0.22E-01		0.22E-01	
ENERGY	-0.118		0.143		-0.86E-01	*	0.53E-01		-0.98E-01	*	0.54E-01	
WAGE	-0.42E-03		0.56E-03		-0.39E-03	**	0.17E-03		-0.29E-03	*	0.18E-03	
RENT	0.14E-01		0.13E-01		0.93E-02		0.62E-02		0.13E-01		0.61E-02	
PRIME (lagged)	-0.94E-02		0.54E-01		0.71E-02		0.22E-01		0.14E-01		0.23E-01	
POP	0.359	**	0.179		0.134	*	0.78E-01		0.72E-01		0.85E-01	
BUSINESS	0.70E-05		0.12E-03		0.11E-03	***	0.38E-04		0.30E-04		0.36E-04	
T	0.42E-02		0.48E-02		-0.58E-02	***	0.21E-02		-0.44E-02	*	0.23E-02	
CROSSOWN	-0.168		0.237		-0.49E-01		0.72E-01		0.52E-01		0.97E-01	
MULTMKT	0.35E-01		0.37E-01		-0.15E-01		0.17E-01		-0.28E-01		0.20E-01	
LEAD	-0.83E-03		0.79E-02		0.45E-02	*	0.27E-02		0.28E-02		0.28E-02	
ENTRY	-0.219		0.156		0.23E-01		0.67E-01		0.43E-01		0.77E-01	
BELLBELL	-0.320		0.589		0.147		0.154		0.99E-01		0.156	
INDBELL	-1.614	***	0.271		-0.29E-02		0.120		-0.168		0.145	
INDIND	-0.323	**	0.345		-0.59E-01		0.136		-0.32E-01		0.130	
Firms dummies												
σ_{11}	0.396	***	0.43E-01		0.149	***	0.112E-01		0.216	***	0.13E-01	
$\rho_{1\epsilon}$	0.391		0.435		-0.825	***	0.676E-01		-0.943	***	0.33E-01	
Adj. R ²	0.8071		0.5149		0.5438							

*** ** * represent significance at the 1%, 5%, 10% levels respectively

**Table 3.2 FIML Estimates: Price Equation
Non-Regulated Markets**

	Low Usage		Middle Usage		High Usage	
	Coeff.	St.Err.	Coeff.	St.Err.	Coeff.	St.Err.
CONSTANT	3.760	***	4.679	***	6.354	***
OPERATE	-0.50E-01	0.53E-01	-0.20E-01	0.17E-01	-0.80E-02	0.29E-01
ENERGY	-0.229	0.160	0.50E-01	0.55E-01	0.72E-01	0.77E-01
WAGE	-0.12E-03	0.25E-03	0.10E-03	0.13E-03	0.74E-04	0.21E-03
RENT	-0.76E-02	0.16E-01	0.24E-02	0.61E-02	-0.15E-02	0.87E-02
PRIME (lagged)	-0.38E-02	0.56E-01	0.62E-01	***	0.60E-01	***
POP	0.278	0.35	0.219	0.151	0.171	0.195
BUSINESS	0.66E-04	0.18E-03	0.53E-04	0.49E-04	0.59E-04	0.73E-04
T	-0.40E-02	0.60E-02	0.31E-02	0.17E-02	0.41E-02	*
CROSSOWN	-0.22E-01	0.151	-0.77E-02	0.46E-01	-0.83E-01	0.69E-01
MULTMKT	0.65E-01	**	0.14E-01	0.88E-02	0.21E-01	0.14E-01
LEAD	0.48E-03	0.68E-02	-0.37E-03	0.21E-02	-0.66E-03	0.35E-02
ENTRY	-0.426	***	0.20E-01	0.48E-01	0.88E-01	0.68E-01
BELLBELL	-0.64E-01	0.220	0.385	***	0.298	**
INDBELL	-0.239	0.545	-0.141	*	-0.389	***
INDIND	-0.136	0.262	-0.224	***	-0.372	**
Firms dummies				***		***
σ_{22}	0.495	***	0.150	***	0.152	***
$\rho_{2\epsilon}$	0.928	***	0.146	0.663	0.225	0.673
Adj. R ²	0.4899		0.6576		0.6620	

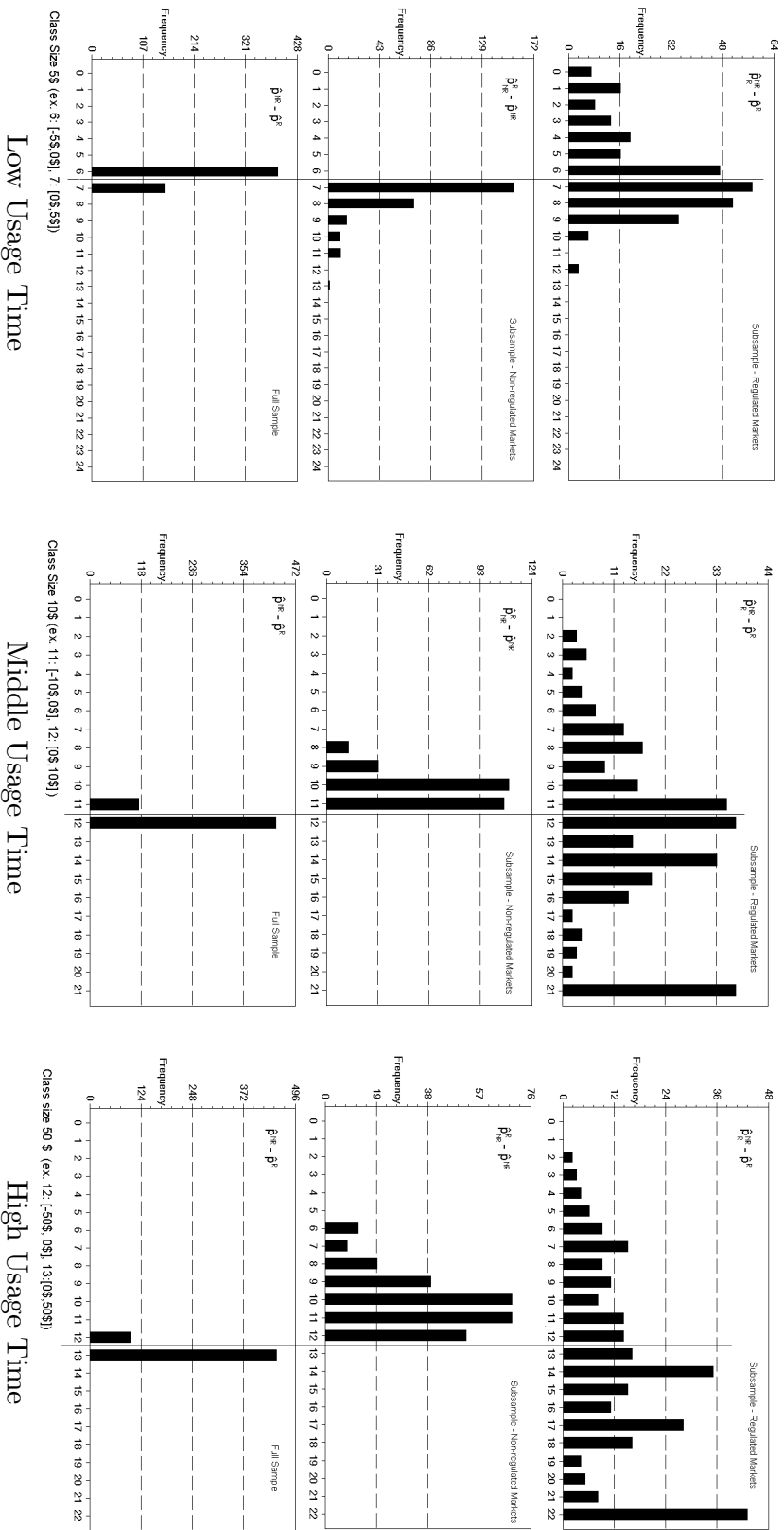
***, **, * represent significance at the 1%, 5%, 10% levels respectively

Table 7. Structural Probit: Firms Lobbying Intensity

	$\log p_{ts}^{1NR} - \log p_{ts}^{1R}$		$\log p_{ts}^{2NR} - \log p_{ts}^{2R}$		$\log p_{ts}^{3NR} - \log p_{ts}^{3R}$	
	Coeff.	St.Err.	Coeff.	St.Err.	Coeff.	St.Err.
USWEST	19.99	79.75	1352.36	4596.68	-938.10	3362.82
BELLSTH	7.56 ***	2.32	35.81	22.96	-30.46 ***	16.40
AMERTECH	165.52	468356.01	205.92	2835124.0	-161.50	1403292.2
NYNEX			323.53	3815116.6	-239.36	3569575.6
SWBELL	-22.41	242662.41	303.02	3095096.7	-492.30	2075926.0
GTE	2.21 **	1.10	-34.55 ***	15.06	31.24 **	10.08
CONTEL	1.92	1.39	3.23	5.72	-9.63	8.41
MCCAW	-20.30	458493.33	1288.83	2174560.5	-1218.19	1497249.3
CENTEL	9.23 **	4.37	14.75 **	6.39	-16.02 **	7.60
REST	-1.35 ***	0.35	2.15	4.90	-14.42 ***	4.61
Log likelihood			-46.72363			
Chi squared			651.9032			
Correct Predictions			96.65%			

*** and ** represent significance at the 1%, and 5% levels respectively

Figure 1. Sample Distribution of the Difference Between Non-regulated and Regulated Prices



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