block carrier in subscribers notwithstanding their delayed beginning of operations by offering innovative service packages better suited to customer demands.

After realizing the fiasco of comparitive hearings, the FCC subsequently used lotteries to award the non-wireline licenses in smaller MSAs and in RSAs. However, for these geographical areas it continued to award the B Block license to the wireline carrier.

III. Competition in Cellular Telephone

The FCC policy to establish a duopoly market structure in cellular telephone has been quite controversial. Originally, the FCC decided with cellular that it would license a single provider in each geographical area although it changed its position on which firm would receive the license. Eventually after much regulatory wrangling, the FCC decided to license two cellular providers in each MSA and later RSAs. This duopoly market structure was subsequently adopted in many other countries in their license policy for cellular. The FCC believed that the duopoly framework provided a reasonable compromise between competition among firms and economies of scale. Arguably, more firm licenses in a given area would increase competition, but they would have higher costs due to lower economies of scale.

An obvious economic point is that the competition among cellular firms could not conceivably approximate the ideal of perfect competition.[4] Fixed costs of switches, cell sites, and radio equipment create economies of scale and are high relative to incremental (marginal) costs. Thus, the situation is one of imperfect competition. Analysis of competition in cellular telephone must account for this fundamental technological basis for imperfect competition.

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[4] This obvious economic point has been missed in a number of government reports on the cellular industry.

The question of how well the duopoly market structure has worked in practice has been the subject of intense debate, at least before regulatory commissions. A number of government agencies have considered competition in cellular telephone, e.g. the General Accounting Office, but their analyses have not been based on either prices or costs in cellular. The studies conclude that the cellular industry is not perfectly competitive; the finding is obvious and expected.

Another basis for evaluation of competition rests on the "structural approach" to industrial organization. Here market shares are calculated and since the 2 competitors have high shares, around 50% each, the structural approach leads to a finding of high concentration and low competition. Often, this approach calculates a Herfindahl index of about 5000 and concludes according to the Merger Guidelines that the industry is "highly concentrated." Here, as with most applications of "structural analysis", very little about the competitive nature of the industry is indicated.

Other approaches which have been taken are to calculate "regulatory rates of return" for cellular companies or to estimate Tobin Q-ratios.[5] Both of these approaches have important shortcomings, e.g. the rate bases used exclude the value of the customer base which represents an investment of $500-700 each because of subsidies given on the initial purchase of cellular telephones. Q-ratios for cellular are found to be quite high, but they are approximately just as high for ESMR companies which are just beginning operation. See Hausman (1994) for a further discussion of these measures of cellular industry competition.

However, these controversies about the existence and possible exercise of market power by the cellular duopolists miss the important point about the outcome of regulation. Can regulation do better than the unregulated duopoly imperfect competition outcome? Advocates of regulation typically hold up the ideal of perfect competition, price equal to marginal (incremental) cost. Yet

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[5] For Q-ratio analysis see Hazlett (1993, 1994) and Haring and Jackson (1993, 1994)

because of the technology of high fixed costs and low marginal costs of cellular (and most telecommunications service technologies), the perfect competition outcome of price equal to marginal cost would be impossible to achieve absent government subsidy.

The need to compare a real world outcome, imperfect competition, to the real world outcome of regulation has been emphasized repeatedly, but the lesson seems to be forgotten by regulatory advocates.[6] O. Williamson has put forward the remediability standard of transactions cost economics:

> "...informed choice among alternative forms of organization entails trade-offs. Identifying and explicating trade-offs is the key to the study of comparative economic organization....Related to this last is the concept of remediability...references to benign government, costless regulation, omniscient courts, and the like are operationally irrelevant.[7]

This standard of comparative institutional analysis considers the effects of regulation on market performance. P. Joskow has also stressed that

> "performance attributes of different feasible market outcomes are compared to one another rather than to an unachievable textbook model...[Often] [t]hese characteristics do not fit a standard textbook model of perfect competition."[8]

Thus, the real world outcome of imperfect competition should be compared to the real world outcome of imperfect regulation in cellular. Textbook ideal situations of perfect competition do not provide an adequate standard of comparison.

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[6] See e.g. Joskow and Rose (1989) for a further discussion of this point.

[7] O.E. Williamson, "Transaction Cost Economics and Organization Theory," Industrial and Corporate Change, 2, 1993.

[8] P.L. Joskow, "Economic Methodologies for Evaluating Competition and Performance in Video Programming and Distribution Markets", 1994 mimeo.

IV. Competition vs. Regulation--Which System is Better for Consumers?

Cellular provides an extremely interesting "natural experiment" to consider the economic effects of regulation. Each cellular geographical market has two providers because of FCC policy. Structural models of industrial organization would imply that the duopoly situation might well lead to an oligopoly outcome with excessively high prices. As I discussed in the previous section, regulatory rate of return calculations and Q-ratios for cellular companies arguably provide some support for this implication. Regulation then becomes an alternative. The primary goal of regulation is to stop the exercise of market power--charging prices above the competitive level.[9] Since about 1/2 the states, 22 to be exact, regulate cellular, we can consider market outcomes.

The question I attempt to answer here is: "Does state regulation of cellular help or harm consumers?" If market power does exist and regulation can do its job, prices should be lower (and output should be higher) in regulated states. The answer I find could not be more different--cellular prices are significantly higher in regulated than in unregulated states. Consumers are harmed by regulation of cellular telephone.

The goal of regulation should be high quality service and competitive prices for consumers. I will examine whether regulation of cellular telephone has achieved these goals. I will concentrate on California in terms of regulatory restrictions since it is the largest state with the most cellular subscribers. The California Public Utility Commission (CPUC) has regulated cellular telephone much more strictly than other states which impose regulation.

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[9] Other goals of telecommunications regulation such as universal service do not arise with cellular telephone.

A. Cellular Prices in Regulated and Unregulated States

An economic analysis of competition in the cellular industry is greatly complicated by two aspects of competition within the industry. First, all cellular companies offer a wide variety of pricing plans. Each plan consists of a monthly access amount and a per minute amount for usage.[10] Higher access charges accompany lower per minute charges. However, many plans also have a number of "free" minutes of usage per month before the usage charge begins. These nonlinear payment schedules make analysis of price changes quite complicated. My approach to this complication has been to calculate the minimum prices of approximate average monthly usage of 160 minutes per month. Using this approach, I have collected data annually for the largest 30 MSAs for the past 9 years. The average price for average monthly usage has decreased by about 36% over the past 9 years and by about 18% over the past 5 years.[11] These decreased prices have accompanied significantly greater demand for cellular telephone as I discussed above so that price decreases for usage are expected given the technology used in cellular.

I now do an initial comparison of cellular service prices for 160 minutes of usages in the top ten MSAs to demonstrate the outcome in regulated and unregulated states. In Table 1 I list monthly service prices in 1994 for the least expensive plan for average usage of 160 minutes per month (80% peak) for up to a 1 year contract:

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[10] Other usage charges occur with "roaming" when a cellular customer travels to other MSAs. Roaming charges vary widely and have become a significant basis of competition, especially in the Boston to Washington corridor.

[11] These price decreases have been accompanied by significant increases in geographical coverage without any additional charge.

Table 1: Average Cellular Prices in the Top 10 MSAs: 1994
160 minutes of use (80% peak)[12]

MSA No.	MSA	Monthly Price	Regulated
1.	New York	$110.77	Yes
2.	Los Angeles	99.99	Yes
3.	Chicago	58.82	
4.	Philadelphia	80.98	
5.	Detroit	66.76	
6.	Dallas	59.78	
7.	Boston	82.16	Yes
8.	Washington	76.89	
9.	San Francisco	99.47	Yes
10.	Houston	80.33	

The fact that regulation goes along with higher monthly service prices is evident from Table 1. Every regulated price in Table 1 is greater than every unregulated price in Table 1! The probability that every regulated price would exceed every unregulated price if the prices had no relationship to regulation is 0.00002. The average price of regulated MSAs is $98.10 while the average price of unregulated MSAs is $70.59, which is a difference of $27.51 per month or 39%. Thus, cellular customers in California as well as New York and Massachusetts are paying a large extra amount each month while consumers in Chicago and Texas are paying considerably lower amounts for their cellular service.[13]

Table 1 demonstrates clearly that regulation of cellular telephone leads to higher prices for consumers. I will first discuss reasons why regulation leads to higher cellular prices. I will then do an econometric analysis which allows me to quantify the higher prices that consumers pay in regulated states. I can also explore the potential objection that economic factors other than regulation explain the higher cellular prices in regulated states.

Why does regulation in California, New York, and Massachusetts (and elsewhere) lead to higher prices? First, regulation causes a company's

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[12] This usage, 160 minutes per month, is the approximate average usage of cellular customers.

[13] The Massachusetts DPU decided in July 1994 to end regulation of cellular telephone.

competitors to know in advance what its prices are going to be. Especially in a duopoly market situation, advance notice of prices or the regulatory required price signalling, can lead to downward stickiness in prices, due to the presence of a single competitor. Furthermore, all cellular service plans must have approved tariffs so that no special offers or secret price cuts are permitted. Economists and antitrust agencies are often concerned that price signalling can lead to decreased price competition.[14] Moreover, a long history exists in economics regarding concerns about posted prices. For instance, Frank Knight wrote in 1921:

> "With perfect intercommunications it would seem that the assumed absence of collusion is very improbable, as organization costs would naturally tend to a low level. Under static conditions (with the existing stocks of all agencies fixed and known), a great development of monopoly would apparently be inevitable." (Knight (1921), p. 193)[15]

Tariff requirements prohibit secret price cutting. Since both cellular operators use almost identical technology in most MSAs, costs will be very similar so that knowledge of prices and costs for your competitor will be known approximately without any violation of the antitrust laws, but instead through the working of the regulatory process. Thus, the Stigler (1964) oligopoly problem of inferring secret price-cutting from market behavior is largely eliminated by regulation. Tariff requirements, even in the absence of explicit regulatory price setting, may have a significant adverse effect on competition as the experience in cellular demonstrates.[16]

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[14] For instance, the US Department of Justice recently charged the airlines with anti-competitive price signalling through the use of computerized reservation systems.

[15] Knight was responding, in part, to the proposal for "open price associations" made in Chicago around 1910 for business to replace "secret, unfair, cutthroat" competition with competition based on open prices.

[16] Tariff requirements in interLATA long distance may also be a significant factor in AT&T's 6 price increases over the past 14 months for residential and small business customers which have been followed each time by its main competitors, MCI and Sprint. See Hausman (1995).

Regulatory procedures adversely effect competition beyond requiring public disclosure of all prices. If your competitor does not like your proposed prices (presumably they are too low) the competitor protests the prices to the California Public Utility Commission (CPUC). Resellers of cellular service are usually the source of protests to the CPUC.[17] These protests increase the costs of operations, and, more importantly, they also deter the introduction of new pricing plans and new service options. In 1993, Nextel, the new ESMR carrier in Los Angeles, protested rate reductions proposed by LACTC (the Block A carrier).[18] The CPUC has not yet resolved these protests regarding the lower priced contracts; and in principle, the CPUC can require the carriers to return their prices to previous higher levels and make retroactive adjustments such as refunds to resellers or other competitors. Furthermore, the carriers expended significant resources in answering the protests. Thus, these competitors' protests have a "chilling effect" on competition.

Also, regulation restricts the ability of cellular companies, to set company specific rates to cause greater usage of cellular. The CPUC also restricts the use of multi-year contracts, by imposing significant restrictions on their terms, which would allow for lower prices. Thus, many pro-competitive outcomes which are usual in competitive, non-regulated industries, are prohibited by the CPUC.

However, the CPUC goes well beyond other states in making certain that regulation leads to higher prices. The CPUC is the only state which imposes a retail margin over wholesale prices. The CPUC enforced markup ranges from 14-38% on access and 18-38% on usage. This enforced margin limits retail competition and leads to higher prices in California. The margin makes absolutely no economic sense in terms of protecting consumers. Its only

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[17] Resellers buy cellular service at tariffed wholesale prices from the two cellular operators and then resell the service to retail customers.

[18] ESMR, enhanced specialized mobile radio, offers a cellular like voice service using digital (TDMA) cellular technology.

effect is to increase the number of resellers who provide an economically inefficient form of cellular distribution. Retail sales of cellular is a business without entry barriers so no market power can be present. However, the CPUC has continued its anti-competitive policy of enforced retail margins in order to protect resellers from competition. While consumer protection is the appropriate policy of regulation, reseller protection, at the expense of consumers, is the outcome of the CPUC policy. Thus, "regulatory capture" has arguably occurred in California; but neither the service providers nor consumers are benefitting. Instead, an economically inefficient group, resellers, benefit from a CPUC protection policy.

B. Econometric Estimation of the Effect of Regulation on Cellular Service Prices

Cellular prices in Table 1 demonstrate that cellular prices are higher in regulated states: every regulated MSA in Table 1 has higher prices than every unregulated MSA. While it is unlikely, it is possible that other economic factors explain the difference in prices. Thus, I now turn to econometric estimation to explore the factors which cause price difference across MSAs. To do so, I collected price data for the period 1989-93 from a (confidential) survey of cellular operators. I use these 5 years of data to run a regression of cellular prices in the top 30 MSAs. These top 30 MSAs contain about 107 million pops (population), or about 41% of the entire U.S. population.[19]

The regression results are given in Table 2. As right hand side variables I use a construction cost index, commuting time, a regulation variable, and indicator variable for each year. Cellular operators use nearly identical technology in their cellular switches and radio equipment, but construction costs are significant because cell splitting requires erection of new towers and radio antennae. Greater commuting times also require additional cell splitting and costs of provision of cellular.

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[19] Note that no truncation or sample selection bias is introduced by use of the top 30 MSAs since population is an exogenous variable.

The left hand column of Table 2 gives the least square estimates of the regression for prices for 160 minutes of use. I find both the construction cost and commuting variables (as well as their interaction) to have a significant effect on the price of cellular in the top 30 MSAs. Also, the yearly indicator variables demonstrate that real cellular prices fell by about 16.7% from 1989 to 1993, after accounting for the cost and commuting variable. The coefficient of the regulation variable is 17.1% which means that regulated states have cellular prices that are 17% higher, holding other economic factors equal.[20] The coefficient is estimated very precisely (standard error = 0.029) and the finding is highly statistically significant (t statistic = 5.98). Thus, the econometric analysis demonstrates that states which regulate do have significantly higher cellular prices in large MSAs as the data in Table 1 demonstrated also. Now in the top 30 MSAs overall, regulated prices are 23.6% higher. Other economic factors explain about 7% of the higher prices and regulation explains 17%. Thus, regulation is the major factor associated with the higher prices.[21]

A possible objection that higher prices may lead to regulation, thus causing the regulation variable to be jointly endogenous, does not make economic sense in the context of cellular. California and other states have regulated cellular since its inception. These states did not adopt regulation in response to high cellular prices. Nevertheless, in the right hand column of Table 1 I estimate the model using instrumental variables (IV). The immediate question arises about what variables should be used as instruments for the regulation variable. I use two types of variables, one regulatory and the other size of government related.

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[20] In previous research using a reduced form specification I have found the coefficient of the regulation variable to be consistently around 15%.

[21] If I consider the effect of regulation in smaller MSAs, the estimated effect is significantly smaller. For instance, in MSAs 31-60 I find that the estimated effect of regulation is about 7% higher prices.

For the regulation instrument I use an indicator variable whether the state also regulates paging. No economic reason exists to regulate paging. Paging is essentially a free entry industry with multiple providers in each MSA providing paging service. Since the FCC opened up the 900 MHz frequency band to paging in the early 1980's, numerous new paging companies have entered and both nominal and real paging prices have decreased significantly.[22] Regulation of paging is independent of cellular prices, but it demonstrates a "propensity to regulate" (unnecessarily).

Regulation must be paid for by taxpayers so the other two instruments that I use reflect the size of government. I use the ratio of state and local government tax expenditures divided by total disposable income and also an indicator variable for high tax states which have the highest marginal incomes tax rate above 10%. These instruments do an excellent job of predicting cellular regulation in a given state.

The IV estimates in the right hand column of Table 2 are very similar to the least squares estimates. The estimates of the coefficients for constructions costs and commuting are very similar, as are the coefficients for the yearly indicator variables. Note that the coefficient of the regulation variable has increased to 23.4%. Thus, based on a Hausman (1978) specification test, the IV estimate for regulation is significantly higher than the least squares estimate of the effect of regulation.

I now repeat the least squares and IV estimation for cellular usage of 250 minutes per month which corresponds to a "heavy user" of cellular telephone. The results are given in Table 3. In the left hand column using least squares estimates, I find again that construction costs and commuting time have a significant positive effect on cellular prices. The yearly indicator variable coefficients demonstrate that cellular prices for large users have decreased somewhat faster, about 19% from 1989 to 1993. The coefficient of the regulation variable is 16.6% which is quite close to the

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[22] Pagenet, by far the largest paging company in the US, began operation in 1981 and provides service over the 900 MHz spectrum range. Older paging companies use spectrum in lower frequency ranges.

17.1% estimate for the effect of regulation for 160 minutes of use. In the right hand column of Table 3 I present the IV results. Again, the construction cost and commuting time variable coefficients, as well as the yearly indicator variables have approximately the same effect. The coefficient of the regulation variable increases to 21.1%. The IV estimate is again significantly greater than the least squares estimate based on a specification test.

Lastly, I estimate a price regression for 30 minutes of use per month. This level of usage represents mostly cellular customers who purchase cellular service for safety related reasons. The least squares estimates in the left hand column of Table 4 again find that construction costs and commuting time affect cellular prices, but the effects are not estimated very precisely. No significant decrease in cellular prices over the period 1989-93 is found. However, a large and significant effect of regulation of 26.6% is estimated for these low usage price plans. The IV estimates find an even larger effect of regulation which is again significantly larger than the least squares estimates. However, the other IV coefficient estimates are very imprecise.

The least squares and IV estimates of the effect of regulation on cellular prices in Tables 2-4 tell a consistent story. State regulation of cellular leads to significantly higher prices, on the order of 15-20% higher. IV estimates find an even higher effect of state regulation of cellular. Thus, the original results in Table 1 that cellular prices are higher in regulated states find support in the econometric estimation.

As a final test of the effects of regulation on cellular prices I recently collected cellular prices for Boston for 160 minutes of use similar to the data in Table 1. Massachusetts deregulated cellular in July 1994. I give the results in Table 7 and compare Boston to Hartford since Connecticut continues to regulate cellular:

Table 7: Minimum Cellular Prices in Boston and Hartford: 1994
160 minutes of use (80% peak)

MSA	Jan 1994	Regulated	Nov 1994	Regulated	% Change
Boston	$79.91	Yes	$69.99	No	-12.4%
Hartford	93.31	Yes	90.75	Yes	-2.7%

Since deregulation in Massachusetts cellular prices have decreased significantly, much in line with the regression prediction that regulation causes cellular prices to be too high by about 17%. Connecticut, which continues to regulate cellular, has both higher prices, and prices have not decreased in Connecticut nearly as much as Massachusetts. Thus, consumers in the Boston MSA have already benefitted significantly from deregulation. Consumers welfare, to the extent it is the goal of regulation, has increased because of deregulation of cellular telephone in Massachusetts.

B. Estimation of Costs to Consumers from Cellular Price Regulation

I now take the regression results and estimate the amount of higher costs to consumers in California from CPUC regulation. Five California MSAs are in the top 30 MSAs: Los Angeles, San Francisco, San Diego, San Jose, and Sacramento. These 5 MSAs have about 24 million people, which is about 75% of California's population. Thus, over 75% of California's population has paid cellular prices significantly higher than I would expect in the absence of regulation. According to the regression results, the cellular prices in California would be about $15.14 per month less for these MSAs. Using the 75% population fraction and approximately 2 million cellular customers in California in 1993 leads to an estimate of $363.4 million per year that the regulation in California is costing cellular customers. This regulatory cost to California consumers is growing at 35-40% per year in line with cellular growth rates in California.

V. Effects of Non-Price Regulation on Cellular Usage

As the regression results demonstrate in Tables 2-4, the real prices of cellular service have decreased by about 17% over the period 1989-93. The main form of competition in cellular, however, has not been on monthly usage charges. Instead, the major focus of competition has been on the initial price of the cellular telephone handset. In 1984 a cellular car phone cost consumers about $2500. The price decreased rapidly to the range of $800-1000. At this point, cellular providers and resellers began to discount the phone prices by offering subsidies to their dealers in the range of $350-500. Thus, the retail price of a cellular telephone became less than its wholesale price.

This initial discount provided the economic and marketing impetus which caused cellular to begin to grow exponentially. Thus, the cellular industry discovered that consumers wanted a low initial cost to become cellular users.[23] The industry offered bundled programs with low cost initial telephones and either 6 month or 1 year usage contracts. These bundled programs have now reached the point that in most places in the U.S. a new cellular user can receive a Motorola "flip phone" either for free or for a payment of about $25-50.[24]

A $400 discount on a cellular phone is competitively very significant. Since the average cellular customer stays on a given network for about 3 years, the undiscounted monthly saving is about $11 per month which can be compared to average monthly usage fees in 1993 of about $61, or a discount of 18%. Most analyses of competition in the cellular industry have neglected this important economic factor.

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[23] The "oversensitivity" to initial cost has been observed in a number of different consumer choice settings. See J. Hausman, "Individual Discount Rates and the Purchase and Utilization of Energy Using Durables," Bell Journal of Economics, 1979.

[24] An important exception is California where the California Public Utility Commission (CPUC) has prohibited bundling. This rule has led to higher prices for cellular consumers in California, consistent with much CPUC policy as I discuss in the next section.

A. Regulatory Restrictions on Non-Price Competition

States which regulate cellular also engage in restriction of non-price competition. For instance, states restrict contract terms and contract length, as well as other contract provisions. In California, the CPUC also causes California to be the only state which does not permit bundling of cellular CPE and cellular service. The effects of this anti-competitive restriction are easy to find. Cellular phones are routinely advertised by large discount stores (e.g. Circuit City or Good Guys) in California for about $125-250. These same cellular phones, when combined with new service activation can be purchased in almost all other areas of the country for between $1.00-$100, depending on the particular model. The resellers have objected to bundling in California, and the CPUC has decided once again that it is better to protect resellers, than to foster competition. Consumers are harmed by this CPUC action since they have to pay higher prices for their cellular CPE. Thus, notwithstanding most economists and the FCC deciding that bundling of cellular CPE is pro-competitive, the CPUC has decided otherwise.

The result has been higher prices to California cellular customers. Yet a further result is a significant decline in cellular usage (penetration) compared to what it would be if bundling were permitted. My previous research has demonstrated that individual purchase decisions are heavily influenced by the "first cost" of equipment purchases. Elimination of bundling causes lower penetration of cellular in California than in other similar MSAs in non-regulated states.

B. Estimation of the Effect on Cellular Output in States with Regulation

Another approach to evaluate the effects of regulation is to compare industry output in states which regulate cellular to states which do not regulate cellular. The consumer harm caused by the actions of a monopolist arise because the monopolist restricts output to cause price to increase. Thus, if regulation is effective in decreasing a possible monopoly power problem in cellular, a minimum (necessary) condition is that regulation should

lead to higher industry output. The results are just the opposite. Regulation leads to lower cellular telephone penetration, i.e. percentage of cellular customers in the population. Thus, on both price grounds and on output grounds, regulation of cellular telephone is anti-consumer and anti-competitive.

To investigate industry output I gathered cellular subscription data from cellular companies in the largest MSAs for the period 1989-93. Since these data are highly confidential, I present the results in index number form. I find that cellular penetration is higher in unregulated MSAs. In Table 5 I give penetration relative to New York.

Table 5: Cellular Penetration in the Top 10 MSAs: 1994

New York is used as basis: New York = 1.0

MSA No.	MSA	1989 Penetration	1993 Penetration	Regulated
1.	New York	1.00	1.00	Yes
2.	Los Angeles	1.42	1.30	Yes
3.	Chicago	2.04	2.92	
4.	Philadelphia	1.45	1.61	
5.	Detroit	1.72	1.74	
6.	Dallas	1.71	2.06	
7.	Boston	1.79	2.35	Yes
8.	Washington	2.47	2.39	
9.	San Francisco	1.37	1.40	Yes
10.	Houston	1.45	1.98	
	Average Regulated	1.29	1.30	Yes
	Average Unregulated	1.82	2.19	

Thus, 1993 penetration is highest in Chicago, an unregulated MSA, with quite low prices as demonstrated in Table 1. Penetration is also high in Washington (unregulated), Boston (regulated), Dallas (unregulated), and Houston (unregulated). Overall, 1993 penetration is higher in unregulated states with an index of 2.19 while penetration in regulated states has an index of 1.30. Also, growth is higher in unregulated than in regulated states. Growth in penetration in unregulated states averaged 32.6% per year while growth in regulated states was 28.2%. Both the higher penetration and the higher growth

rates in unregulated states are consistent with the lower prices in unregulated states and the greater decrease in prices since 1989 in unregulated states.

In Table 6 I do an econometric analysis of cellular demand. Here the left hand side variable is the number of subscribers and the right hand side price variable is the log of price for 160 minutes along with variable for log of income, log of population, log of commute time, regulation, and year. The least squares estimate of the price elasticity is -0.41 which is estimated quite precisely (standard error = 0.15). This elasticity estimate explains the results, at least in part, of why cellular penetration is higher in unregulated states with their lower prices. In addition to the effects of higher prices, states which regulate have 16.1% lower cellular penetration (t-statistic = 2.5)[25] This negative 16.1% effect of regulation is in addition to the effect of higher prices which leads to about 7% lower cellular penetration. Note that the population variable estimate is 0.95, which is not statistically different from 1.0, as would be expected. A significant effect of commuting time in the MSA is also found to be important.

Also, in Table 6, in the middle column, I reestimate the demand model using instrumental variables. This estimation methodology takes account of possible joint endogenity of price and demand. When I use instrumental variables on the model, I estimate the demand elasticity to be -0.51 (standard error = 0.17). Thus, I find a somewhat higher elasticity estimate than before which would yield a larger effect of higher prices in regulated states on reducing demand for cellular. When I do a Hausman specification test, I do not reject the elasticity estimate from the initial model. Note that the parameter estimate for the other variables, e.g. population, remain virtually the same. The estimate of the effect of regulation, apart from price, is estimated to be 14.7%.

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[25] This additional negative effect likely arises from anti-bundling rules and prohibitions on customer specific contracts in states which regulate cellular telephone.

Lastly, in the right hand column of Table 6 I again do IV estimation allowing for both price and regulation to be jointly endogenous. The IV results remain very similar to the previous results. The estimated price elasticity is -0.50 and the effect of regulation, apart from price, is estimated to be -14.8%. Thus, regulation is found to have both significant price and non-price effects on cellular penetration.

VI. Estimation of the Overall Effect of Regulation on Consumer Welfare

Cellular output is lower in regulated states with the main reason for this result being consumer response to the higher prices in regulated states. This outcome of higher prices and lower output because of regulation demonstrates that regulation harms cellular consumers. While regulators such as the CPUC may have other goals such as protection of resellers or may have problems in believing that unregulated markets operate better than regulated markets, the market evidence is quite clear. Regulation of cellular telephone harms consumers.

To estimate the overall effect on consumer welfare, I use an exact consumers surplus approach using the expenditure function for the log linear demand curve used in Table 6. First, I use the expenditure function calculated in Hausman (1981), equation (23):

$$e\ (p, \overline{u}) = [\ (1-\delta)\ \ (\overline{u} + Ap^{1+\alpha}/(1+\alpha))\ ]^{1/(1-\delta)} \qquad (1)$$

where A is the intercept of the demand curve, α is the price elasticity, and δ is the income elasticity estimate in Table 6. The compensating variation is calculated from equation (1) where y is income:

$$CV = \left\{ \frac{(1-\delta)}{(1+\alpha)}\ y^{-\delta}\ [p_1 x_1 - p_0 x_0]\ + y^{(1-\delta)} \right\}^{1/(1-\delta)} - y \qquad (2)$$

The calculation of the compensating variation from equation (2) created by regulation is $238.82 per year, or estimated for California the amount is $477.6 million per year for the entire California population which includes cellular customers who pay higher prices and lost consumer's surplus for individuals who would purchase cellular at the lower non-regulated price.

The expenditure function can also be used to calculate the lost consumer welfare from the non-price effects of regulation. Here I consider an increase in the intercept coefficient A from the demand curve in equation (1) by 14.8% which is the estimate of the non-price effect of cellular regulation. Note that this calculation is not strictly correct based on the original indifference map because the outward shift of the demand curve causes two different indifference maps to be compared.[26] The approach I take to allow comparison of similar indifference maps is to solve for the change in price which would cause the 14.8% non-price shift in demand and to calculate the compensating variation from this price decrease using equation (2). When I use the change in price which would cause a 14.8% increase in demand, I find that consumers surplus would increase in California by about 1.97 times as much as the effect of lower prices. On a California wide basis I calculate the overall yearly loss to regulation to be about $1.41 billion per year.

The last question which I attempt to answer is how much consumer's surplus was lost by the original delay by the FCC in licensing cellular in the US. This regulatory indecision caused a new good, cellular telephone, to be unavailable in the US when it was being offered in Scandinavia and Japan using technology invented by AT&T Bell Labs. I use the methodology first put forward by Hicks (1940) and recently expanded and applied by Hausman (1994). The main idea is to calculate the reservation or virtual price which causes demand for the good to be zero using the expenditure function from equation (1) and the corresponding Hicksian (compensated) demand curve. I only attempt to approximate this welfare loss by asking the question: if cellular had been

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[26] This problems from shifts in the demand curve is a common problem in welfare measurements.

available in 1983 with a 10 year history but because of more limited and higher cost microprocessors and other semiconductor chips it cost twice as much (in 1983 dollars) as it does in 1994, what was the lost consumers surplus? I estimate that the lost consumers surplus was approximately $24.3 billion in 1983 dollars or about $33.5 billion in current 1994 dollars. Even if I assume that demand for cellular would only have been 1/2 as great in 1983 because of decreased functionality, I still estimate a welfare loss of approximately $16.7 billion.[27] As expected, the consumer welfare cost of holding up the introduction of a new good is much larger than the effects of higher prices or other regulatory effects on demand, because the entire consumer's surplus is lost when regulatory delays cause demand to be zero.

VII. Conclusion

Cellular telephone's phenomenal success has changed the way that Americans live and work. Mobile communications has been combined with the mobile life style that has characterized the changes in the U.S. economy since WWII. The average 1 hour per day that commuters near large MSAs spend in their cars going to and from work is now increasingly accompanied by the ability to communicate about business matters while commuting. Also, convenient sized portables have led to the ability to find people "anytime and anywhere" (at least in the U.S.). Furthermore, safety and security while driving has increased since drivers have a telephone with them at all times.

Thus, the FCC's cellular policy has been an outstanding success. Arguments about the competitiveness of the duopoly market structure continue; however, I believe that the arguments are fundamentally misguided. The alternative to duopoly competition in cellular has been state PUC regulation of cellular. State PUC regulation of cellular has been a failure since prices are higher and output is lower in states which regulate cellular compared to

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[27] Jackson et. al (1991) earlier estimated a welfare loss of about $85 billion from the delay in introducing cellular telephone into the U.S., assuming the delay to be 10 years.

states which don't regulate cellular. Thus, if the duopoly market structure creates a "problem" of the exercise of market power, the attempted cure worsens the disease. State regulation of cellular telephone costs consumers hundreds of millions of dollars per year in the misguided belief of state regulators that protecting competitors, here resellers, is more important than protection of consumers through competition.

This lesson, that duopoly competition can be better than regulation, may become increasingly important in the future when two providers of broadband services compete for residential customers. State regulators assume (as a matter of faith) that their regulation is better than a situation of imperfect competition. No economic theory nor wideranging empirical study supports this assumption. Cellular telephone proves it to be false in this particular industry. Important decisions on the future of one of the two most important and dynamic sectors of the U.S. economy should not be based on false assumptions. Competition, even imperfect competition, usually provides a more pro-competitive outcome and greater consumer welfare than regulation. This lesson should affect economic and policy choices by Congress, the FCC, and state regulators as communication becomes increasingly important to the functioning of our society and to the future of the U.S. economy.

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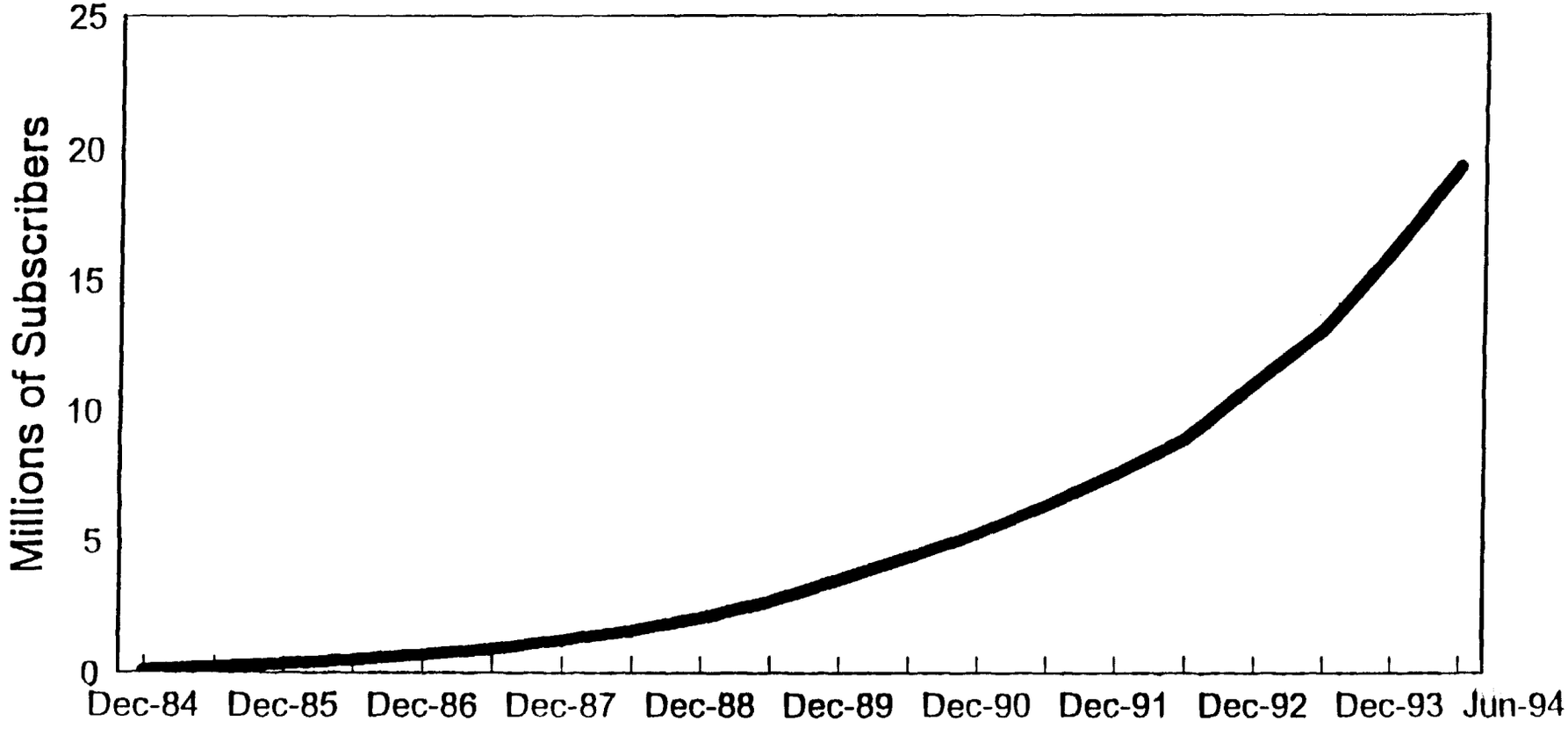
Figure 1

Cellular Subscribers, 1984-1994



Source: CTIA End-of-Year Data Survey

Table 2

1989-93 Price Regression for Top 30 Cellular Markets <1
Left hand Side Variable: Log of Price at 160 MOU <2

Variable	OLS	Instrumental Variables <3
Intercept	4.153 (0.105)	4.129 (0.107)
Log of Commute Time <4	0.207 (0.101)	0.193 (0.103)
Log of Construction Cost <5	1.461 (0.457)	1.255 (0.468)
Interaction between Commute Time and Construction Cost	1.669 (0.477)	1.533 (0.485)
Regulation	0.171 (0.029)	0.234 (0.036)
Year 89	0.167 (0.034)	0.163 (0.035)
Year 90	0.120 (0.034)	0.115 (0.034)
Year 91	0.067 (0.033)	0.064 (0.033)
Year 92	0.034 (0.032)	0.033 (0.033)
Number of Observations	198	198
Standard Error of Regression	0.148	0.150
R Squared	0.403	---

Notes:
1> Standard errors in parentheses.
2> Minimum monthly bill is based on 128 minutes of peak calling and 32 minutes of off-peak calling.
3> Instruments include an indicator variable for state regulation of paging, maximum marginal state income tax rates, and state taxes as a percentage of personal income.
4> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.
5> Source: "Boeckh Building Cost Index Numbers".

Table 3

1989-93 Price Regression for Top 30 Cellular Markets <1
Left hand Side Variable: Log of Price at 250 MOU <2

Variable	OLS	Instrumental Variables <3
Intercept	4.601 (0.087)	4.583 (0.088)
Log of Commute Time <4	0.365 (0.083)	0.355 (0.084)
Log of Construction Cost <5	1.120 (0.375)	0.971 (0.383)
Interaction between Commute Time and Construction Cost	1.213 (0.392)	1.115 (0.397)
Regulation	0.166 (0.024)	0.211 (0.029)
Year 89	0.189 (0.028)	0.186 (0.029)
Year 90	0.139 (0.028)	0.135 (0.028)
Year 91	0.074 (0.027)	0.071 (0.027)
Year 92	0.042 (0.027)	0.040 (0.027)
Number of Observations	198	198
Standard Error of Regression	0.121	0.123
R Squared	0.543	---

Notes:
1> Standard errors in parentheses.
2> Minimum monthly bill is based on 200 minutes of peak calling and 50 minutes of off-peak calling.
3> Instruments include an indicator variable for state regulation of paging, maximum marginal state income tax rates, and state taxes as a percentage of personal income.
4> Mean commute time from home to work. Source: 1990 U.S. Census. Tape File 3c.
5> Source: "Boeckh Building Cost Index Numbers".