24. The price elasticity estimates -0.4 to -0.5 are inconsistent with claims that the cellular carriers in each MSA are behaving like a "shared monopoly". Basic theory in economics states that a monopolist always finds it to be profit maximizing to raise price until the price elasticity exceeds 1.0 (in magnitude). Here the magnitude of the price elasticity estimate between 0.40 and 0.50 is far different than 1.0. Indeed, a t test rejects the hypothesis that the price elasticity could be as high as 1.0 (t statistic = 3.87). Thus, the demand equation estimates demonstrate that the cellular duopolists are not setting prices consistent with monopoly behavior.

25. Another interesting result arises from the regression results in Appendix 4. Note that the effect of regulation is to lead to lower cellular demand by 16.1% (t statistic 2.5). Thus states like California which restrict the terms of long term contracts, restrict the terms of special company specific contracts, and restrict the terms of promotions cause cellular demand to be lower, even after holding population and cellular price constant. Given the scarcity and economic value of the spectrum used for cellular, this added negative effect of regulation harms consumers and leads to less use of the spectrum than in unregulated states.

## IV. Conclusion

26. Prices are higher in large MSAs which are regulated. Price decreases are lower in large MSAs which are regulated. Penetration is lower in large MSAs which are regulated. Demand for cellular is decreased in large MSAs which are regulated because of higher prices. Demand for cellular is decreased in large MSAs, even beyond the price effect, because of other restrictions on cellular promotions and contracts. All of these effects demonstrate that cellular regulations harms consumers. Yet the goal of regulation should be to help consumers. Thus, it is time the FCC pre-empted regulation and stopped state regulators in California, New York and other

states from causing further harm to cellular customers.

Jerry Hausman

Subscribed and sworn to before me
this 14th day of September 1994.

Notary Public
My commission Expires 7/3/1998

**May 1994**

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## EDUCATION:

OXFORD UNIVERSITY
D. Phil. 1973 (Ph.D)
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BROWN UNIVERSITY
A.B. (Summa Cum Laude), 1968

**THESIS:** "A Theoretical and Empirical Study of Vintage Investment and Production in Great Britain," Oxford University, 1973.

## FELLOWSHIPS, HONORS AND AWARDS:

Phi Beta Kappa
Marshall Scholar at Oxford, 1970-1972
Scholarship at Nuffield College, Oxford, 1971-1972
Fellow of Econometric Society, 1979.
Frisch Medal of the Econometric Society, 1980
Fisher-Schultz Lecture for the Econometric Society, 1982
John Bates Clark Award of the American Economic Association, 1985
Jacob Marschak Lecture for the Econometric Society, 1988
American Academy of Arts and Sciences, 1991.

## EMPLOYMENT:

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

| | |
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| 1992- | John and Jennie S. MacDonald Professor |
| 1979- | Professor, Department of Economics |
| 1976-79 | Associate Professor, Department of Economics |
| 1973-76 | Assistant Professor, Department of Economics |
| 1972-73 | Visiting Scholar, Department of Economics |

VISITING APPOINTMENTS:

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| 1986-87 | Visiting Professor, Harvard Business School |
| 1982-83 | Visiting Professor, Harvard University Department of Economics |

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## PROFESSIONAL ACTIVITIES:

Associate Editor, Bell Journal of Economics, 1974-1983
Associate Editor, Rand Journal of Economics, 1984-1988
Associate Editor, Econometrica, 1978-1987
Reviewer, Mathematical Reviews, 1978-1980
American Editor, Review of Economic Studies, 1979-82
Associate Editor, Journal of Public Economics, 1982-
Associate Editor, Journal of Applied Econometrics, 1985-1993
Member of MIT Center for Energy and Environmental Policy Research, 1973-
Research Associate, National Bureau of Economic Research, 1979-
Member, American Statistical Association Committee on Energy Statistics, 1981-1984
Special Witness (Master) for the Honorable John R. Bartels, U.S. District Court for the Eastern District of New York in Carter vs. Newsday, Inc., 1981-82
Member of Governor's Advisory Council (Massachusetts) for Revenue and Taxation, 1984-1992
Member, Committee on National Statistics, 1985-1990
Member, National Academy of Social Insurance, 1990-
Member, Committee to Revise U.S. Trade Statistics 1990-1992
Director, MIT Telecommunications Economics Research Program, 1988-
Board of Directors, Theseus Institute, France Telecom University, 1988-
Member, Conference on Income and Wealth, National Bureau of Economic Research, 1992-

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### I. Econometrics

"Minimum Mean Square Estimators and Robust Regression," Oxford Bulletin of Statistics, April 1974.

"Minimum Distance and Maximum Likelihood Estimation of Structural Models in Econometrics," delivered at the European Econometric Congress, Grenoble: August 1974.

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"An Instrumental Variable Approach to Full-Information Estimators in Linear and Certain Nonlinear Econometric Models," Econometrica, May 1975.

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"A Conditional Probit Model for Qualitative Choice," delivered at World Econometric Congress, Toronto: August 1975; MIT Working Paper 173, April 1976; Econometrica, with D. Wise, March 1978.

**PUBLICATIONS cont.:**

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"The Econometrics of Labor Supply on Convex Budget Sets," Economic Letters, 1979.

"Panel Data and Unobservable Individual Effects," with W. Taylor, MIT Working Paper 225; Econometrica 49, November 1981.

"Comparing Specification Tests and Classical Tests," with W. Taylor, August 1980, Economic Letters, 1981.

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"Stochastic Problems in the Simulation of Labor Supply," presented at NBER conference, January 1981; in Tax Simulation Models, ed. M. Feldstein, University of Chicago Press, 1983.

"The Design and Analysis of Social and Economic Experiments," invited paper for 43rd International Statistical Institute Meeting, 1981; Review of the ISI.

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"Full-Information Estimators," in Kotz-Johnson, Encyclopedia of Statistical Science,vol. 3, 1983

"Instrumental Variable Estimation," in Kotz-Johnson, Encyclopedia of Statistical Science, vol. 4, 1984

**PUBLICATIONS cont.:**

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"Errors in Variables in Panel Data," with Z. Griliches, Journal of Econometrics, 1986.

"Specifying and Testing Econometric Models for Rank-Ordered Data," with P. Ruud; Journal of Econometrics, 1987.

"Semiparametric Identification and Estimation of Polynomial Errors in Variables Models," with W. Newey, J. Powell and H. Ichimura, 1986, Journal of Econometrics, 1991.

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"Nonlinear Errors in Variables: Estimation of Some Engel Curves," Jacob Marschak Lecture of the Econometric Society, Canberra 1988, forthcoming in Journal of Econometrics.

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"Valuation of New Goods Under Perfect and Imperfect Competition," mimeo April 1994.

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"Appliance Choice with Time of Day Pricing," Energy Laboratory Report, January 1980.

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**JOINT REPORTS, TESTIMONY, AND BOOKS cont.:**

"Individual Savings Behavior," with P. Diamond, Report to the National Commission on Social Security, May 1980.

"Wealth Accumulation and Retirement," with P. Diamond, Report to the Department of Labor, May 1982.
"A Review of IFFS," Report to the Energy Information Agency, February 1982.

"A Model of Heating System and Appliance Choice," with J. Berkovec and J. Rust, December 1983.

"Labor Force Behavior of Older Men After Involuntary Job Loss," with L. Paquette, Report to Department of Health and Human Services, December 1985.

"Pollution and Work Days Lost," with D. Wise and B. Ostrow, NBER Working Paper, January 1984; Revised 1985.

"Demand for Interstate Long Distance Telephone Service," with A. Jafee and T. Tardiff, November 1985.

"Competition in the Information Market 1990", August 1990.

The Choice and Utilization of Energy Using Durables, ed. J. Hausman, Palo Alto: EPRI, 1981.

Social Experimentation, ed. J. Hausman and D. Wise, Chicago: 1985.

Future Competition in Telecommunications, ed. S. Bradley and J. Hausman, Harvard: 1989.

Contingent Valuation: A Critical Appraisal, ed. J. Hausman, North Holland, 1993.

Globalization, Technology and Competition, ed. S. Bradley, J. Hausman, R. Nolan, Harvard 1993.

JAH/lag

**1994 Price Regression for Top 30 Cellular Markets**
Left hand Side Variable: Log of Price <1

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 0.539 | 2.052 |
| Log of Income <2 | 0.203 | 0.236 |
| Log of Population <3 | -0.029 | 0.052 |
| Log of Commute Time <4 | 0.624 | 0.266 |
| Regulation | 0.150 | 0.052 |

| | |
|---|---|
| Number of Observations | 58 |
| Standard Error of Regression | 0.148 |
| R Squared | 0.396 |

Notes:
1> Minimum monthly bill is based on 128 minutes of peak calling and 32 minutes of off-peak calling.
2> Log of per capita personal income. Source: Survey of Current Business, April 1992.
3> Log of population. Source: 1992 Statistical Abstract.
4> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.

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

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 2.549 | 1.150 |
| Log of Income <2 | 0.075 | 0.143 |
| Log of Population <3 | 0.050 | 0.030 |
| Log of Commute Time <4 | 0.091 | 0.170 |
| Regulation | 0.142 | 0.029 |
| Year 89 | 0.173 | 0.041 |
| Year 90 | 0.127 | 0.036 |
| Year 91 | 0.075 | 0.034 |
| Year 92 | 0.039 | 0.033 |
| Number of Observations | 198 | |
| Standard Error of Regression | 0.152 | |
| R Squared | 0.367 | |

Notes:
1> Minimum monthly bill is based on 128 minutes of peak calling and 32 minutes of off-peak calling.
2> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
3> Log of population. Source: NPA Data Services, Inc., April 1994.
4> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.

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

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 1.027 | 0.918 |
| Log of Income <2 | 0.256 | 0.114 |
| Log of Population <3 | 0.048 | 0.024 |
| Log of Commute Time <4 | 0.129 | 0.136 |
| Regulation | 0.150 | 0.023 |
| Year 89 | 0.159 | 0.033 |
| Year 90 | 0.122 | 0.029 |
| Year 91 | 0.070 | 0.027 |
| Year 92 | 0.040 | 0.027 |
| Number of Observations | 198 | |
| Standard Error of Regression | 0.121 | |
| R Squared | 0.543 | |

Notes:
1> Minimum monthly bill is based on 200 minutes of peak calling and 50 minutes of off-peak calling.
2> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
3> Log of population. Source: NPA Data Services, Inc., April 1994.
4> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.

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

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 4.701 | 1.752 |
| Log of Income <2 | -0.278 | 0.217 |
| Log of Population <3 | 0.027 | 0.046 |
| Log of Commute Time <4 | 0.257 | 0.259 |
| Regulation | 0.184 | 0.044 |
| Year 89 | 0.102 | 0.062 |
| Year 90 | 0.082 | 0.055 |
| Year 91 | 0.072 | 0.051 |
| Year 92 | 0.063 | 0.051 |
| Number of Observations | 198 | |
| Standard Error of Regression | 0.232 | |
| R Squared | 0.165 | |

Notes:
1> Minimum monthly bill is based on 24 minutes of peak calling and 6 minutes of off-peak calling.
2> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
3> Log of population. Source: NPA Data Services, Inc., April 1994.
4> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.

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

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 4.341 | 0.411 |
| Log of Income <2 | -0.023 | 0.044 |
| Log of Population <3 | -0.066 | 0.010 |
| Regulation | 0.186 | 0.023 |
| Year 89 | 0.267 | 0.048 |
| Year 90 | 0.289 | 0.024 |
| Year 91 | 0.193 | 0.019 |
| Year 92 | 0.059 | 0.018 |

| | |
|---|---|
| Number of Observations | 577 |
| Standard Error of Regression | 0.169 |
| R Squared | 0.356 |

Notes:
1> Minimum monthly bill is based on 128 minutes of peak calling and 32 minutes of off-peak calling.
2> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
3> Log of population. Source: NPA Data Services, Inc., April 1994.

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

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 4.137 | 0.417 |
| Log of Income <2 | 0.025 | 0.045 |
| Log of Population <3 | -0.049 | 0.010 |
| Regulation | 0.159 | 0.024 |
| Year 89 | 0.291 | 0.047 |
| Year 90 | 0.329 | 0.024 |
| Year 91 | 0.191 | 0.019 |
| Year 92 | 0.058 | 0.018 |

| | |
|---|---|
| Number of Observations | 578 |
| Standard Error of Regression | 0.172 |
| R Squared | 0.359 |

Notes:
1> Minimum monthly bill is based on 200 minutes of peak calling and 50 minutes of off-peak calling.
2> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
3> Log of population. Source: NPA Data Services, Inc., April 1994.

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

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 3.524 | 0.530 |
| Log of Income <2 | -0.068 | 0.057 |
| Log of Population <3 | 0.012 | 0.012 |
| Regulation | 0.124 | 0.030 |
| Year 89 | 0.122 | 0.061 |
| Year 90 | 0.256 | 0.031 |
| Year 91 | 0.170 | 0.025 |
| Year 92 | 0.086 | 0.023 |

| | |
|---|---|
| Number of Observations | 577 |
| Standard Error of Regression | 0.218 |
| R Squared | 0.160 |

Notes:
1> Minimum monthly bill is based on 24 minutes of peak calling and 6 minutes of off-peak calling.
2> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
3> Log of population. Source: NPA Data Services, Inc., April 1994.

**1989-93 Demand Regression for Top 30 Cellular Markets**
Left hand Side Variable: Log of Subscribers

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 0.851 | 2.528 |
| Log of Price <1 | -0.402 | 0.155 |
| Log of Income <2 | 0.188 | 0.309 |
| Log of Population <3 | 0.949 | 0.065 |
| Log of Commute Time <4 | 0.958 | 0.363 |
| Regulation | -0.161 | 0.067 |
| Year 89 | -1.225 | 0.092 |
| Year 90 | -0.807 | 0.080 |
| Year 91 | -0.552 | 0.072 |
| Year 92 | -0.308 | 0.071 |

| | |
|---|---|
| Number of Observations | 196 |
| Standard Error of Regression | 0.322 |
| R Squared | 0.982 |

Notes:
1> Minimum monthly bill is based on 128 minutes of peak calling and 32 minutes of off-peak calling.
2> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
3> Log of population. Source: NPA Data Services, Inc., April 1994.
4> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.

**1989-93 Demand Instrumental Variable Regression for Top 30 Cellular Markets <1**
Left hand Side Variable: Log of Subscribers

| Variable | Estimate | Standard Error |
|---|---|---|
| Intercept | 1.094 | 2.531 |
| Log of Price <2 | -0.500 | 0.172 |
| Log of Income <3 | 0.196 | 0.309 |
| Log of Population <4 | 0.954 | 0.065 |
| Log of Commute Time <5 | 0.965 | 0.363 |
| Regulation | -0.147 | 0.068 |
| Year 89 | -1.209 | 0.093 |
| Year 90 | -0.795 | 0.080 |
| Year 91 | -0.545 | 0.073 |
| Year 92 | -0.304 | 0.071 |

| | |
|---|---|
| Number of Observations | 196 |
| Standard Error of Regression | 0.321 |
| Hausman Specification Test ($\chi^2_1$) | 1.73 |

Notes:
1> Instrumental variables include average price across other Top 30 MSAs, per capita income, population, commute time, and indicator variables for regulation and years.
2> Minimum monthly bill is based on 128 minutes of peak calling and 32 minutes of off-peak calling.
3> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
4> Log of population. Source: NPA Data Services, Inc., April 1994.
5> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.

# THE CELLULAR SERVICE INDUSTRY: PERFORMANCE AND COMPETITION

Prepared for:

THE CELLULAR TELECOMMUNICATIONS INDUSTRY ASSOCIATION

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## The Performance of the Cellular Industry

From its beginning, the business of supplying cellular telephone communications has been characterized by rapidly increasing volume, declining prices, expanded service offerings, and significant technological change.

The volume of cellular services can be measured either by the number of subscribers or by the minutes of airtime used. The number of cellular telephone subscribers had grown from only 91,600 in January 1985 to an estimated 8.8 million by June 1992. Growth has continued to be rapid, with the number of cellular subscribers increasing by 46 percent during the 12 months ending June 1991 and by 39 percent in the 12 months ending June 1992.[1] The number of cellular subscribers is projected to be 19 million by 1995 and 38 million by 2001.[2] Growth in cellular airtime also has been substantial, although it has been slower than the growth in the number of subscribers because later subscribers have tended to use the service less intensively than earlier adopters. This change reflects the increased importance of residential users of cellular telephones relative to business users.

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[1]Cellular Telecommunications Industry Association, Industry Data Survey, June 30, 1992, p. 1. The growth in volume that has occurred has far exceeded expectations. When commercial cellular service began in the United States in 1983, the potential demand in the year 2000 was thought to be between one and two million subscribers; see Coopers & Lybrand, Technological Change and the Cellular Telecommunications Industry (November 1991), p. 15.

[2]Linden Corporation, Cellular Network Technology, End User Requirements, and Competition to the Year 2001, 1991, p. 244.

Contributing to this increasing volume has been a steady decline in the costs of owning and using cellular telephones. For example, the nominal price for 250 minutes of prime airtime usage per month across the ten largest cellular service areas had, in 1989, declined by 19 percent from the inception of commercial cellular service in 1983. Even with a slight increase in carrier charges estimated for 1991 and 1992, the unweighted average of the lowest published rate for access and 250 minutes of usage during prime time in these ten service areas was only 85 percent of its 1983 level. When adjusted for inflation, the average of these rates in the ten largest cellular service areas in 1991 was only 62 percent of its 1983 level.[3]

The monthly cost of a mobile cellular telephone has declined by even more than carrier charges, from $79 in 1983 to $7 in 1991. During the same time, the quality of mobile telephone service was also enhanced by improvements in functions and features. When adjusted for inflation, the total cost of owning and using a cellular telephone in 1991 was only 44 percent of its cost in 1983.[4]

Cellular subscribers have benefitted not only from falling prices but also from the continually expanding variety of services offered by cellular operators. Only five years ago, there were no

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[3]Data are from Herschel Shosteck Associates, Ltd., Cellular Market Forecasts, Data Flash, September 1992.

[4]Data are from Shosteck, op. cit., and measure the "drive away" price of a single mobile telephone, including antenna, installation, and first-year maintenance.

value-added cellular services. Today, cellular providers offer a number of information services as well as features such as voice mail, call forwarding, and call waiting. There have been major advances in data transmission as well, including portable facsimile and wireless transmission for laptop computers. New services continue to be developed. For example, cellular telephones now are being used to verify credit cards and to transmit information to and from remote locations in computerized monitoring and reporting systems.

Technological advances in recent years also have enabled cellular systems to expand their capacity. Several capacity-increasing innovations have occurred in the conventional or analog cellular technology, such as adjusted power output, antenna tilting, dynamic channel assignment, and cell repeaters and umbrella (underlay/overlay).[5]

Notwithstanding the continuing improvements in analog-based cellular systems, even more dramatic advances are expected from the further development and application of digital technology. Virtually all cellular switches made today are digital, and the shift to this technology is expected to occur in base station radios and subscriber telephones during the 1990s.[6]

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[5]H. Shosteck, "The question marks over PCNs," Mobile Europe, January 1991, no pagination.

[6]Coopers & Lybrand, op. cit., pp. 59-60. During a transition period, cellular phones will be dual mode, adaptable to both digital and analog systems.

The conversion to digital technology, despite the substantial investment required, promises to yield even greater increases in system capacity and lower average costs for cellular operators. For example, the capacity of base stations will at least triple initially. In addition, digital technology will permit new services to be provided.[7]

Competition in the Supply of Cellular Services

This performance of the cellular service industry is the kind that economists associate with a young industry driven by market forces and developing in a competitive context,[8] and it has occurred without the industry's having a competitive structure, as economists define that term.[9] The FCC has determined that the cellular service business should be a structural duopoly: only two facilities-based suppliers, one wireline carrier and one nonwireline carrier, are permitted to operate in a service area, with additional facilities-based entry barred. Economists have recognized, however, that the behavior of firms and the performance of an industry can approximate the competitive outcome even if the

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[7] Ibid., p. 60.

[8] While this record of performance is consistent with a competitive industry, it does not prove that the industry is necessarily competitive, since even a monopolist facing conditions of increasing demand and reduced costs is likely to earn greater profits by lowering price, expanding output, and making innovations in products and methods of production.

[9] Economists call a market structure competitive when entry is easy, firms are numerous, and no firm has a large market share. As we point out in the text, the performance of a market can be competitive even if its structure is not.