HASTINGS LAW JOURNAL

SYMPOSIUM ISSUE
MIXED SIGNALS: ACADEMIC AND INDUSTRIAL PERSPECTIVES ON THE TELECOMMUNICATIONS ACT OF 1996

A General Framework for Competitive Analysis in Wireless Telecommunications

by
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The Telecommunications Act of 1996 sets forth extensive provisions to "unbundle" the local telecommunications network to encourage the development of a competitive market for local telephony.[1] It would seem to have been an unstated premise of those statutory provisions and the Federal Communications Commission (FCC) rules interpreting them that the task of unbundling is one that should take place in a technological vacuum. Although the Telecommunications Act of 1996 ostensibly removed artificial regulatory distinctions based on the particular technology employed to produce a communications service, the administrative rulemakings and federal court litigation that have dominated the first three years of experience under the new statute have focused on the traditional wireline access network and have seemingly ignored the fact that, over the same period, wireless telecommunications has rapidly matured as a substitute for wireline access. If regulators were to acknowledge that development, the entire exercise of wireline unbundling could become irrelevant.

Wireless local telephony already provides a substitute for wireline access. It is therefore highly pertinent for a symposium on

1. *See* 47 U.S.C. §§ 251-52 (Supp. 1996). For detailed discussions of this open-access regulation, see J. GREGORY SIDAK & DANIEL F. SPULBER, DEREGULATORY TAKINGS AND THE REGULATORY CONTRACT: THE COMPETITIVE TRANSFORMATION OF NETWORK INDUSTRIES IN THE UNITED STATES (1997), and Robert G. Harris & C. Jeffrey Kraft, *Meddling Through: Regulating Local Telephone Competition in the United States*, 11 J. ECON. PERSP. 93 (1997).

interconnection, such as this one, to consider the FCC's policies that artificially constrain the market structure for wireless telecommunications services. The Supreme Court's 1999 decision in *AT&T Corp. v. Iowa Utilities Board*,[2] reversed the FCC's unbundling rules for incumbent local exchange carriers to the extent that the agency failed to establish a reasonable standard for determining whether it is "necessary" to unbundle a particular element and whether the failure to unbundle that element would "impair" an entrant's ability to compete in the provision of local telecommunications services.[3] In this Article, we propose a general framework for evaluating competition in wireless telecommunications. Although our analysis has immediate ramifications for wireless telecommunications policies—such as spectrum caps and mergers of wireless carriers—the same analysis can shed light on the question of whether, or for how long, it is "necessary" to mandate the unbundling of even the copper loop, which constitutes the element of the wireline network that is considered the least susceptible to duplication by competitors. If wireless is indeed an access substitute for wireline copper loops, and if wireless thus permits the competitive supply of bundled services that are satisfactory substitutes in consumers' minds for the typical bundle of services that consumers have until now demanded in conjunction with standard wireline access, then Congress, the FCC, the state public utilities commissions, and the courts must ask: Is the great experiment of mandatory unbundling of telecommunications networks worth the candle?

That consequential question emerges from the analysis that we employ to study a seemingly narrower issue of wireless telecommunications policy. By regulation, the FCC has limited to 45 MHz the amount of commercial mobile radio services (CMRS) spectrum that may be licensed to a single entity within a particular geographic area.[4] As the Commission stated in its 1998 notice of proposed rulemaking (NPRM) concerning possible relaxation of the spectrum cap, "a single entity may acquire attributable interests in the licenses of broadband Personal Communications Service (PCS), cellular, and Specialized Mobile Radio (SMR) services that cumulatively do not exceed 45 MHz of spectrum within the same geographic area."[5] We formulate, in this Article, a decision rule that

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2. 525 U.S. 366 (1999).

3. *Id.* at 377.

4. *See* 47 C.F.R. § 20.6 (1998).

5. In the Matter of 1998 Biennial Regulatory Review—Spectrum Aggregation Limits for Wireless Telecommunications Carriers, 13 FCC Rcd 25,132 (1998) (Notice of Proposed Rule Making adopted Nov. 19, 1998) [hereinafter *Spectrum Cap NPRM*].

would assist the Commission in deciding whether or not to retain the spectrum cap and, thereafter, in evaluating competition in wireless telecommunications generally.

We employ decision-theoretic analysis to determine whether the expected costs of retaining the 45 MHz spectrum cap exceed the expected costs of removing it. The expected costs of removing the spectrum cap are negligible. The probability of either monopolization by a single firm or collusive pricing by a group of firms is near zero due to the growing tendency of carriers to adopt nationwide pricing plans and because capacity is a function of both spectrum *and* equipment. In contrast, the expected costs of retaining the spectrum cap are substantial as wireless services evolve from mobile voice to fixed voice and data applications. The probability that a single carrier would use more than 45 MHz is nontrivial, because the growth in demand due to consumers' desire for bundled service offerings and the invasion of wireless carriers into fixed communications markets will together severely burden existing networks. In short, a cost-benefit analysis demonstrates that the spectrum cap should be abolished because the expected costs of retaining the spectrum cap vastly exceed the expected costs of removing it.

The application of decision-theoretic analysis to the issue of spectrum cap policy can easily be generalized to deal with a broad range of competitive policy issues in the wireless industry. We restate the decision rule in terms that can be applied to numerous wireless policy issues. For example, regulators may have to decide whether newly merged firms should be forced to divest themselves of wireless properties in overlap territories. The issue of divestiture is treated in similar fashion to the spectrum cap analysis. Not surprisingly, may of the same factors that influence the spectrum cap analysis resurface in the merger analysis.

In Part I of this Article, we explain our decision-theoretic rule for determining whether the spectrum cap should be retained. In Part II, we estimate the expected costs of removing the cap and describe the magnitude of those costs in qualitative terms. In Part III, we present the same analysis with respect to the expected costs of retaining the cap. In Part IV, we compare the expected costs of retaining and removing the spectrum cap. In Part V, we demonstrate the general applicability of our decision-theoretic approach to competitive policy in the wireless communications industry. We conclude by noting how the increasing substitutability of wireless and wireline services is blurring the definitions of relevant market in the telecommunications industry—a development that has direct implications for whether, and how much, to mandate unbundling of the incumbent wireline network.

I. An Application of the Decision-Theoretic Framework to Spectrum Cap Policy

Decision theory is a branch of the social sciences that explores the issue of making optimal decisions in complex environments.[6] We employ decision-theoretic analysis to determine whether the expected cost of retaining the FCC's 45 MHz spectrum cap exceeds the expected cost of removing it. The expected cost of any random event is the product of the probability of the event and the associated cost given that the event occurred. For example, if the probability of a successful robbery with the front door open is 10 percent and the valuables in the home are worth $10,000, then the expected loss from leaving the door unlocked is $1,000 = .10 x $10,000.

The frequency and severity of the errors that might arise under the existing policy regime (the 45 MHz spectrum cap) must be weighed against the frequency and severity of the errors that might arise under the alternative policy regime (abandonment of the cap). We believe that such an approach is consistent with Commission's first principle for deciding whether to eliminate the spectrum cap—"that trusting in the operation of market forces generally better serves the public interest than regulation."[7]

The spectrum cap decision unavoidably will entail two kinds of expected social costs. The first is the loss in consumer welfare resulting from the failure to prevent the successful exercise of market power by a single firm, or a group of firms acting in explicit or tacit collusion, plus the associated enforcement costs of remedying that loss in the absence of the cap. The second is the efficiency loss that would ensue if at least one carrier would have chosen to use, for procompetitive or efficiency-enhancing reasons, more than 45 MHz of spectrum in the absence of the cap, plus the associated enforcement costs of remedying that loss in the presence of the cap.

The cap should be abolished if the expected costs of retaining the cap exceed the expected costs of removing it. This principle is simply a variant on the argument, familiar in antitrust policy, that a liability rule should minimize the combined costs of false positives (Type I errors), false negatives (Type II errors), and the costs of administration.[8] Eminent economists such as Kenneth J. Arrow,

6. For a general explanation of the decision-theoretic framework, see JEAN-JACQUES LAFFONT, THE ECONOMICS OF UNCERTAINTY AND INFORMATION (1995); and DAVID M. KREPS, A COURSE IN MICROECONOMIC THEORY 71-120 (1990).

7. Spectrum Cap NPRM, supra note 5, at ¶ 5.

8. See Paul L. Joskow & Alvin K. Klevorick, A Framework for Analyzing Predatory Pricing Policy, 89 YALE L.J. 213, 223 (1979); Frank H. Easterbrook, Predatory Strategies

William J. Baumol, and Paul W. MacAvoy have extended that economic reasoning to the optimal design of telecommunications regulation.[9] A Type I error is the failure of the Commission to deter a *harmful* event—namely, the loss in consumer welfare resulting from monopolization by a single firm of a particular geographic region or collusion by a group of firms in that geographic region. In contrast, a Type II error is the failure of the Commission to allow a *beneficial* event—namely, the efficiency gain that would be realized when a single carrier uses more than 45 MHz of spectrum for a procompetitive or efficiency-enhancing purpose.

It is important to note that the spectrum-cap problem could just as easily be cast as maximizing the expected gains from the two types of fortuitous events. The expected loss associated with the Type II error (namely, the loss in productive efficiencies due the increase in the minimum efficient scale) is equivalent to the productivity gains that might occur should the cap be removed. Likewise, the expected loss associated with the Type I error (namely, the loss in consumer welfare due to monopolization or collusion in a geographic region) is equivalent to the gain in consumer welfare that might occur should the cap be retained.

The expected cost of removing the spectrum cap equals the product of (1) the probability that a large carrier or a cartel of carriers will exert market power within a particular region and (2) the sum of the associated loss in consumer welfare and the enforcement costs of remedying that loss. We designate as a Type I error the event in which government policies would fail to deter a single firm, or a group of firms acting collusively, from exercising market power within a particular region after the removal of the 45 MHz spectrum cap. The expected cost of keeping the spectrum cap is the product of (1) the probability that the minimum efficient scale for at least one firm exceeds the spectrum cap and (2) the sum of the efficiency losses and

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and Counterstrategies, 48 U. CHI. L. REV. 263, 318–19 (1981); Richard C. Schmalensee, *On the Use of Economic Models in Antitrust: The* ReaLemon *Case*, 127 U. PA. L. REV. 994, 1018–19 n.98 (1979); J. Gregory Sidak, *Debunking Predatory Innovation*, 83 COLUM. L. REV. 1121, 1144–45 (1983). These scholars in law and economics in turn borrowed the construct of Type I and Type II errors from hypothesis testing in statistics. *See, e.g.*, PAUL G. HOEL, INTRODUCTION TO MATHEMATICAL STATISTICS 108–09 (4th ed. 1971).

    9. *See* WILLIAM J. BAUMOL & J. GREGORY SIDAK, TOWARD COMPETITION IN LOCAL TELEPHONY 131–32 (1994); PAUL W. MACAVOY, THE FAILURE OF ANTITRUST AND REGULATION TO ESTABLISH COMPETITION IN MARKETS FOR LONG-DISTANCE TELEPHONE SERVICES (1996); Kenneth J. Arrow et al., *The Competitive Effects of Line-of-business Restrictions in Telecommunications*, 16 MANAGERIAL & DECISION ECON. 301, 305 (1995) (explaining that the "goal of public policy in telecommunications should not be simply to minimize potential regulatory problems but instead to maximize net benefits to society."). *See, e.g.*, J. Gregory Sidak, *Telecommunications in Jericho*, 81 CAL. L. REV. 1209, 1216–17 (1993).

the enforcement costs of remedying those efficiency losses. We designate as a Type II error the event in which the continued enforcement of the spectrum cap would prevent at least one firm from achieving a minimum efficient scale that exceeded the 45 MHz spectrum cap.

It is useful to formalize the conceptual process by which the Commission would optimally define its spectrum-cap rule. The proper goal should be to maximize consumer welfare, which can be achieved at an operational level if the Commission seeks to minimize the total costs C:

$$C = \begin{cases} p\left(L_p + A_p\right) & a\ Type\ I\ error \\ q\left(L_q + A_q\right) & a\ Type\ II\ error \end{cases}$$

where

p =the probability that the Commission fails to deter a single carrier, or a group of carriers acting collusively, from exercising market power (that is, the probability of a Type I error)

L_p =the consumer welfare loss associated with a Type I error

A_p =the enforcement costs of remedying damages in the event that a single carrier or a group of carriers exerts market power

q =the probability that at least one carrier would have chosen to use more than 45 MHz of spectrum (that is, the probability of a Type II error)

L_q =the efficiency loss associated the Type II error

A_q =the enforcement costs of remedying damages in the event of a Type II error

In the following pages we explore in qualitative terms the magnitudes of the probability of the Type I and Type II errors and their associated social costs.

II. The Expected Costs of Removing the Spectrum Cap

A. The Probability That the FCC Fails to Deter a Single Carrier, or a Group of Carriers Acting Collusively, from Exercising Market Power

The probability of a Type I error (that is, the probability that, once the cap is removed, the FCC fails to deter a single carrier, or a group of carriers acting collusively, from exercising market power) is close to zero. As we explain in this Part, at least seven considerations support that conclusion. First, competition in wireless services is robust and is expected to strengthen. Second, a rational firm must consider the pricing reactions of its rivals while contemplating any price increase. Given the growing tendency of carriers to adopt nationwide pricing plans, it is highly unlikely that such a price increase would induce competitors to raise prices in a given location. Thus, any attempt by a firm to monopolize wireless services in a particular region would cause its revenues to fall, because existing customers would flock to the lower-priced national carriers. Third, a rational carrier would recognize that even a smaller rival in the same region could absorb virtually all of the first carrier's traffic given the current technology. Fourth, because capacity is a function of both spectrum and equipment, any exercise of market power would require virtual monopolization of both the spectrum and telecommunications equipment markets.[10] Given the independent ownership of telecommunications equipment and services firms, this event is highly doubtful. Fifth, ease of entry into the wireless voice and data services market undermines the ability of any single firm, or any group of firms acting collusively, to exercise market power. Sixth, the durable nature of spectrum would render any attempted monopolization or collusion futile. Seventh, warehousing of spectrum is not a feasible means to monopolize the wireless services industry. We now consider each of these seven factors.[11]

(1) Competition in the Wireless Services Industry

In an attempt to spur competition in the U.S. wireless industry,

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10. This presumes that other carriers in the region have at least some spectrum.

11. The likelihood of a Type I error with respect to collusion is low not only for all the reasons that we will address, but also for the absence of familiar predisposing characteristics for successful collusion—such as uniform prices, penalties for price discounts, advance notices of price change, information exchanges, and delivered pricing. *See* DENNIS W. CARLTON & JEFFREY M. PERLOFF, MODERN INDUSTRIAL ORGANIZATION 416-17 (2d ed. 1994); RICHARD A. POSNER & FRANK H. EASTERBROOK, ANTITRUST: CASES, ECONOMIC NOTES, AND OTHER MATERIALS 336-38 (2d ed. 1981).

the FCC in the mid-1990s auctioned spectrum for a second generation of wireless service known as personal communication services (PCS). The first major broadband PCS auction (the "A & B Auction") closed on March 13, 1995.[12] The second (the "C Auction") and third (the "D, E & F Auction") broadband PCS auctions closed on May 5, 1995, and August 26, 1996, respectively.[13] The amount of spectrum in each auction varies from 10 MHz in the D, E, and F bands to 30 MHz in the A and B bands.

At the time of the spectrum auctions, the FCC imposed several constraints on the ability of firms to aggregate spectrum in a given geographic region. First, the Commission created a 45 MHz spectrum cap on any combination of broadband Personal Communication Services (PCS), Specialized Mobile Radio Service (SMR), and cellular licenses.[14] The FCC justified the cap as a means of stabilizing the marketplace without sacrificing the benefits of procompetitive and efficiency-enhancing aggregation. If a carrier were to aggregate sufficient amounts of spectrum, the Commission reasoned, it would be possible for the carrier to "exclude efficient competitors, to reduce the quantity or quality of services provided, or to increase prices to the detriment of consumers."[15]

In addition to creating the spectrum cap, the FCC imposed other constraints on the ability of a single carrier to aggregate spectrum. For example, the FCC placed restrictions on the ability of cellular carriers to bid in the PCS auctions.[16] The Commission also set aside two entrepreneurs' blocks, C and F, to ensure that "designated entities" had an opportunity to participate in the provision of broadband PCS.[17] The designated-entities set-asides, cellular PCS cross-ownership restrictions, and spectrum cap represented a strong effort on the part of the FCC to diversify ownership in the wireless industry.

Aggregation rules, like the spectrum cap, are no longer

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12. For the full schedule and summary of spectrum auctions, see Wireless Telecommunications Bureau, U.S. Federal Communications Commission, *Auction Charts* (last modified July 22, 1999) <http://www.fcc.gov.wtb.auctions/>.

13. *See id.*

14. *See* 47 C.F.R. § 20.6 (1998).

15. *Spectrum Cap NPRM, supra* note 5, at 10.

16. The Commission "retain[ed] [its] cellular attribution threshold of 20 percent equity ownership of a cellular licensee and [its] service area overlap test of 10 percent of the population of the relevant PCS market, so that the same entity generally may not own more than 20 percent of a cellular license, and not more than 5 percent of a PCS license(s)." In the Further Order of Consideration, 59 Fed.Reg. 55,372 (1994) (citing New Personal Communications Services, 59 Fed. Reg. 32,830, 32,832 (1994) (to be codified at 47 C.F.R. Pts. 2, 15, 24)).

17. Implementation of Section 309(j) of the Communications Act—Competitive Bidding, 59 Fed. Reg. 37566 (1994) (to be codified at 47 C.F.R. pt. 24).

necessary, as competition in the wireless industry is robust. Before the auctions, no region in the country was served by more than three wireless carriers.[18] As early as June of 1998, 273 of 493 basic trading areas (BTAs), representing 87 percent of the U.S. population, were served by three or more competitors.[19] Four or more carriers served 135 BTAs, representing 69 percent of the population.[20]

In addition to this actual competition, potential competition is substantial. The number of competitors will continue to rise as winners of the D, E & F Auction enter the industry. For example, Sprint launched service in Jacksonville, Tampa, and St. Petersburg in 1998 and is planning to introduce service in Atlanta, Chicago, Cincinnati, Houston, Richmond, and Orlando early 1999.[21] In Chicago and Houston, Sprint represented the sixth wireless carrier as of the end of 1998. Local exchange carriers have also entered as wireless providers in areas where they have had a wireline presence. BellSouth entered Tampa-St. Petersburg in October 1998, with expansion planned into the neighboring counties.[22] By late 1998, U S WEST had entered Phoenix, Denver, and Portland, Oregon, and planned thereafter to expand into the surrounding areas north through Seattle.[23]

Finally, the entrance of PCS carriers is placing significant downward pressure on wireless prices. Industry analysts expect prices of cellular service to continue to fall as PCS firms continue to start operations. Indeed, the expected rate of decline in cellular prices has accelerated over the last few years. Figure 1 shows forecasts of cellular service prices (in constant dollars of revenue per minute of use) prepared by Donaldson, Lufkin & Jenrette ("DLJ"). DLJ expects cellular prices to continue declining by substantial amounts over the next several years.[24] A comparison of DLJ's 1996 and 1998 forecasts shows that cellular prices have fallen even more rapidly than DLJ expected as recently as 1996.

18. This includes the two cellular carriers and potentially Nextel, which began offering digital mobile telephone service in August 1993. For a complete description of Nextel's development, see 1998 FCC ANN. REP. 16 [hereinafter THIRD ANNUAL REPORT].

19. See id. at 19.

20. See id.

21. See Sprint PCS, Current News Releases (visited Feb. 1, 1999) <http://www.sprintpcs.com/news/1999/index.html>.

22. See BellSouth Corporate Information Center, Newsroom (visited Feb. 1, 1999) <http://www.bellsouthcorp.com/headlines/>.

23. See U.S. West News Center (visited Feb. 1, 1999) <http://www.uswest.com/news/commarchive.html>.

24. See DONALDSON, LUFKIN & JENRETTE, THE WIRELESS COMMUNICATIONS INDUSTRY 20 (spring 1998 ed.) [hereinafter DLJ REPORT].

FIGURE 1: DECLINE IN FORECAST PRICES FOR CELLULAR
SERVICE
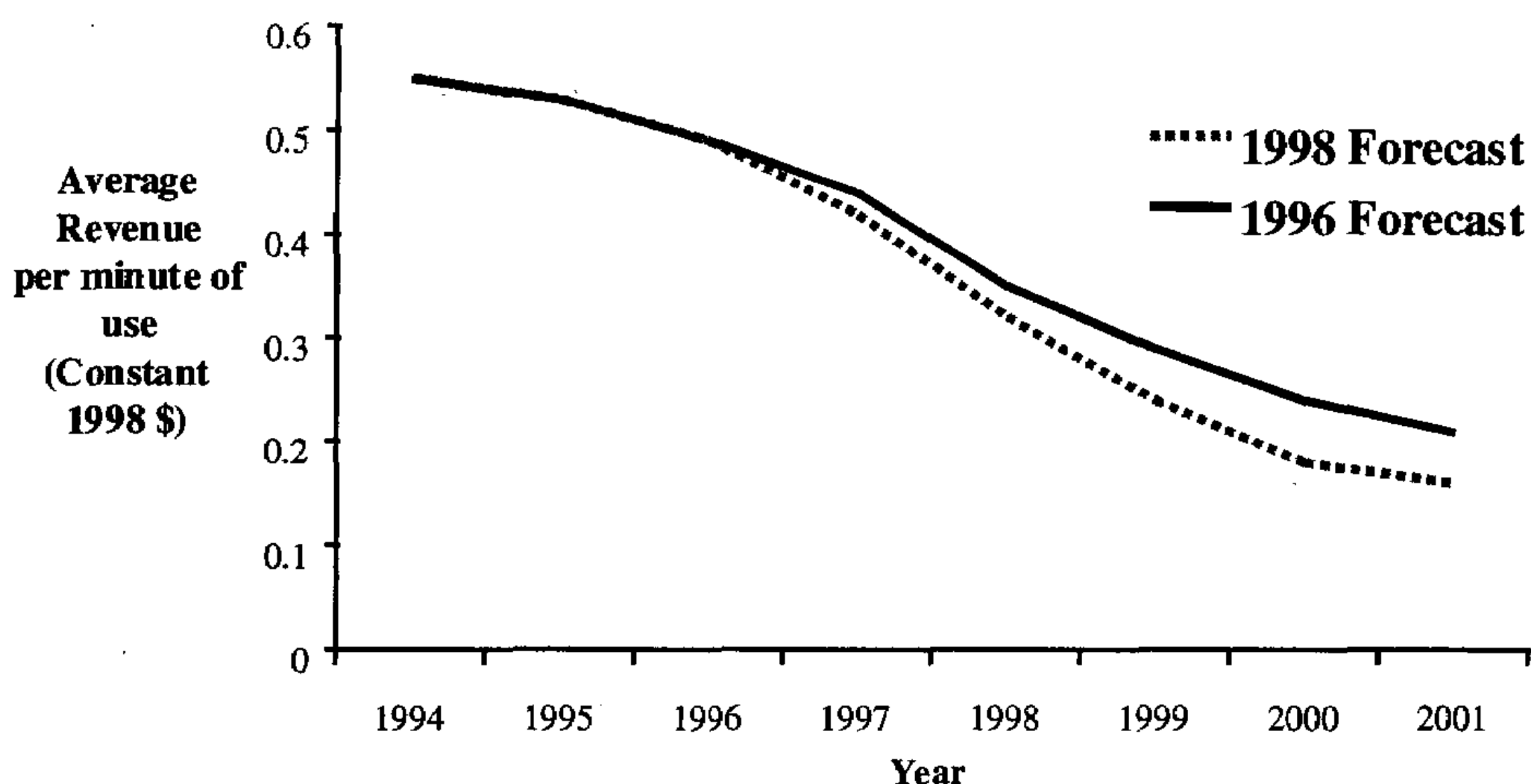
Source: DONALDSON, LUFKIN & JENRETTE, THE WIRELESS
COMMUNICATIONS INDUSTRY 16 (summer 1996 ed.); DONALDSON,
LUFKIN & JENRETTE, THE WIRELESS COMMUNICATIONS INDUSTRY
20 (spring 1998 ed.).

*(2) The Ability of Nationwide Carriers to Raise Prices Selectively in
Particular Regions*

The geographic scope of wireless markets has increased over
time due to an increasing degree of integration between regional
markets and to the emergence of national carriers and pricing plans.
Carriers have attempted to create a nationwide footprint through
purchases of complementary spectrum, acquisitions of
complementary firms, joint ventures, and leasing agreements. With a
virtually nationwide footprint in place, carriers have launched single-
rate plans to lure customers from competing cellular services and
even wireline services. The FCC has identified footprint expansion as
a major operational trend in the wireless industry.[25] As evidence in
support of this trend, the Commission in May 1998 cited the
announcement by SBC Communications to acquire Southern New
England Telecommunications Corp. and its cellular licenses and
Nextel's acquisition of Pittencrieff, the second largest SMR operator
at the time.[26] After its recent sale to SBC, Brian Roberts, president of
Comcast Cellular "acknowledged the trend toward national and
global competitors in the wireless industry."[27]

25. THIRD ANNUAL REPORT, *supra* note 18 at 16.
26. *See id.* at 17.
27. Colleen McElroy, *Comcast purchase opens Northeast for SBC presence,* HOUS.

Examples of nationwide pricing are abundant. Nextel, a "maverick" firm, introduced a "no roaming" plan in January 1997.[28] Established providers have responded to Nextel's innovation. Sprint launched its national plan in early 1998, [29] and AT&T Wireless followed suit in May 1998.[30] Bell Atlantic and AirTouch began to offer single-rate plans in September 1998.[31] The presence of such nationally advertised "one-rate" plans substantially reduces (or eliminates) any concern that carriers could amass spectrum in an effort to extract monopoly rents in any given region.

Any rational firm considering a price increase must contemplate the response of its rivals in the same region. Given the high likelihood that at least one of those rivals employs a nationwide pricing plan, the expected payoff of any price increase by a local carrier will always be less than the expected payoff under no price increase. A nationwide carrier would be insensitive to local changes in prices. Thus, any unilateral price increase would induce the immediate exit of customers to the lower-priced nationwide carrier.[32] Recognizing that futile outcome, the firm would not attempt the localized price increase.

(3) Capacity Is a Function of Both Spectrum and Equipment

It is erroneous on economic grounds to purport to measure the capacity of a wireless firm on the basis of spectrum alone. Rather, capacity is a function of at least two variables—spectrum *and* equipment. It is natural to consider the tradeoff between spectrum and equipment while keeping a constant level of capacity. Thus, a single firm attempting to monopolize a particular region, or any group of firms colluding to raise prices there, would have to dominate both the available supply of spectrum and the available supply of capacity-expanding equipment.[33] Table 1 shows that the wireless telecommunications equipment manufacturers have substantial market capitalizations. It is highly improbable that a single carrier, or

CHRON., Jan. 21, 1999, at 1.

28. *See Nextel Launches Florida and Ohio Valley Markets*, PR NEWSWIRE, July 31, 1997.

29. *See* Elizabeth Douglass, *Telecom Talk 'Roaming' Era Nears Its End*, L.A. TIMES, Oct. 5, 1998, at B6.

30. *See id.*

31. *See id.*

32. This example assumes that the price of the local carrier is originally greater than or equal to the price of the nationwide carrier. Even if the opposite were true, consumers will be inclined to drop the local service because the product offering of the nationwide carrier is superior.

33. It is important to note that there is no cross-ownership whatsoever between the major wireless service carriers and telecommunications equipment firms.

even a cartel of carriers, could coordinate arrangements with all the requisite equipment providers so that a smaller rival in the same location could not augment its capacity through equipment upgrades. As Table 1 shows, monopolization of the wireless equipment industry by wireless service firms would be next to impossible.

Table 1:Wireless Equipment Manufacturers and Market Capitalization

Company	Market Capitaliz. (U.S. $ B)	Profile
Alcatel	19.1	Manufactures wireless equipment and systems, including wireless access systems, mobile networks, microwave radio etc.
Andrew Corporation	1.7	Manufactures base station antennas, antenna, microwave and wireless systems, microwave transmission lines.
Ericsson	44.5	Develops and manufactures systems and terminals for private radio systems and customer-specific mobile data solutions for GSM and Mobitex, wireless handsets and accessories, switches and various wireless systems for network operators.
Glenayre Technologies	0.3	Manufactures paging infrastructure and devices, enhanced services for mobile and fixed networks, spread spectrum and microwave radio and equipment.
Harris Communications	3.1	Manufactures microwave radio systems and wireless local loop telephony systems.
Lucent Technologies	145.5	Manufactures wireless networks, third generation systems, and services systems and software which enable network operators and other service providers to provide wireless access, local, long distance and international voice, data and video services and cable service.

Motorola	41.3	Manufactures wireless handsets, wireless data networks, digital and analog cellular telephone networks, wireless software and modules.
Nokia	83.5	Supplies telecommunications systems and equipment. Core businesses include the development, manufacture and delivery of operator-driven infrastructure solutions and end-user-driven mobile phones.
Nortel	37.4	Designs, develops, manufactures, markets, sells, finances, installs and services fully digital telecommunications systems, including phones, switches and software.
Qualcomm	4.5	Designs, develops, manufactures, markets, licenses, and operates digital wireless communications, infrastructure and subscriber products, designs and services.
Scientific-Atlanta, Inc.	2.1	Manufactures advanced terrestrial and satellite network products and systems to deliver voice, data and video communications services
Tellabs	16.9	Manufactures many wireless solutions such as digital trunk translators and various products that support need to expand capacity of existing facilities
Titan Corporation	0.2	Manufactures satellite communications systems, information technology solutions, and sterilization systems and services for commercial and government customers worldwide

Note: Market capitalization downloaded from http://www.yahoo.com on Jan. 18, 1999.

(4)   The Capacity of a Single Alternative 10 MHz Carrier

At present, digital PCS systems using code division multiple access (CDMA) technology—the most spectrally efficient technology

commercially available today—build their systems in units of capacity called "carriers." Each carrier requires approximately 2.5 MHz of spectrum. In addition, guard bands are required on both ends of the spectrum to prevent interference. Therefore, a PCS provider can build three carriers in a 10 MHz block of spectrum. Initially, each provider builds out a single carrier, but as subscribers and peak-period usage expand, a second carrier is installed. PCS providers using CDMA technology in the A and B blocks, which were auctioned in 1996, are only now beginning to install second carriers for use in 1999.[34] As of February 1999, no wireless carrier had begun to deploy a third carrier, and few are expected to do so in the foreseeable future.

Suppose a single firm tried to monopolize a particular region by first gaining a large share of the available spectrum and then raising prices. Based on the aforementioned capacity of spectrum, one 10 MHz block of spectrum would be sufficient to provide a wireless carrier with the ability to satisfy the current demand for wireless voice services. Thus, so long as there remained at least one 10 MHz carrier in the same region willing to match the old price of the larger firm, that smaller firm would be poised to absorb most of the larger firm's traffic due to the technological capabilities of spectrum management. Recognizing the ability of a smaller rival to absorb its traffic, the large firm would not proceed with a price increase, as the expected payoff of high prices and no customer base would be less than the expected payoff with lower prices and its existing customer base.

Perhaps the best evidence that 10 MHz is sufficient spectrum to allow a firm to be competitive in the present wireless voice industry is the experience of Nextel. Operating with an average of 14 MHz of spectrum in each region (which, for technological reasons, is roughly equivalent to a 10 MHz PCS block of spectrum), Nextel has become a dynamic competitor, providing innovative services and leading in the development of a uniform nationwide pricing plan.[35] As Figure 2 shows, Nextel now operates with systems that can reach 100 percent of the population in the ten largest MSAs, 90 percent of the population in the fifty largest MSAs, and more than 81 percent of the population in the 100 largest MSAs.

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34. Sprint has begun to deploy second carriers in the largest metropolitan areas for use in early 1999. GTE and Bell Atlantic are considering such a deployment for 1999.

35. In the fourth quarter of 1998, Nextel added 372,500 domestic subscribers, bringing the total to 2.8 million. *See* Sarah Schafer, *Nextel Improves 4th-Quarter Result*, WASH. POST, Feb. 24, 1999, at E3.

FIGURE 2: MARKETS IN WHICH NEXTEL OPERATES
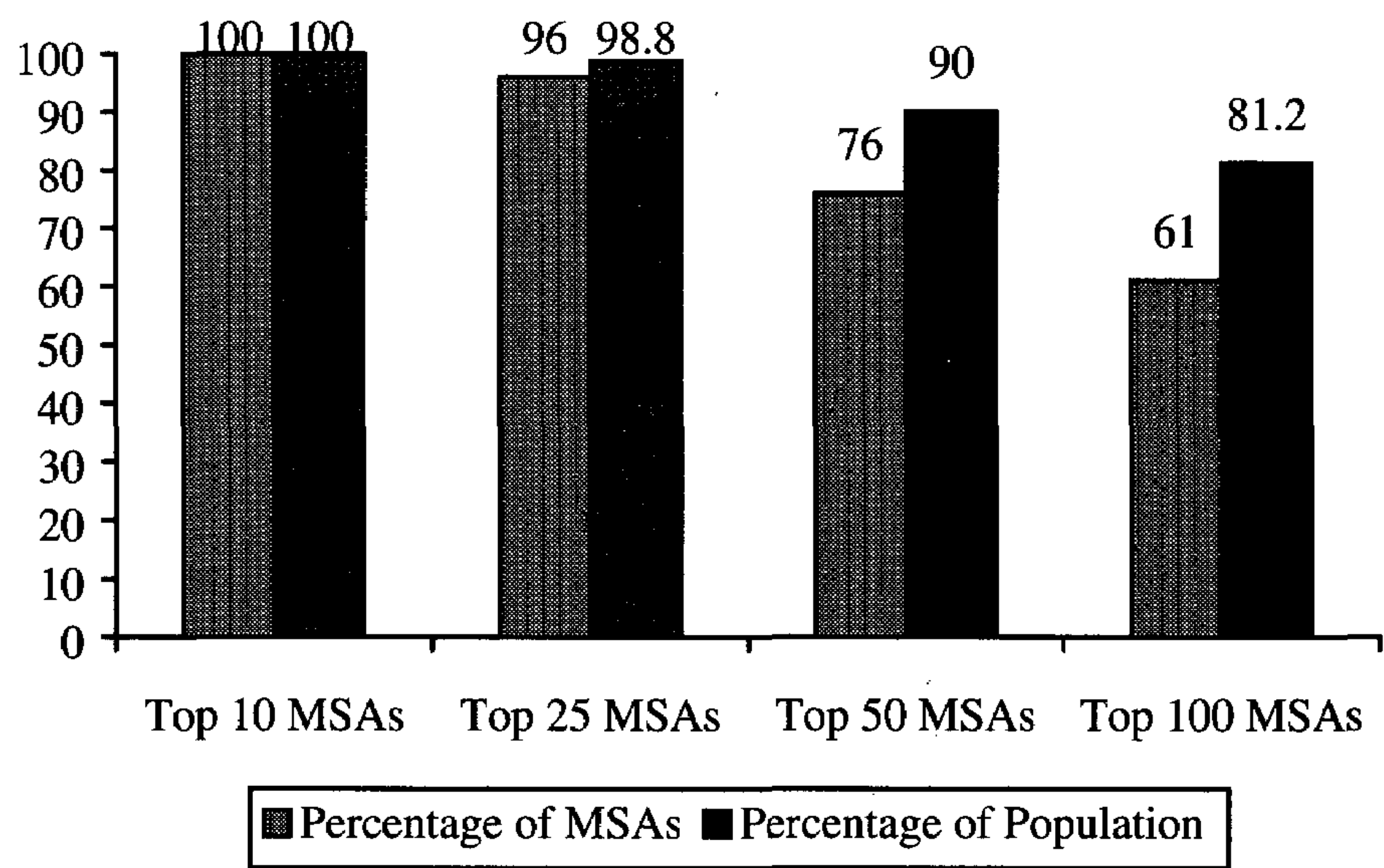
Source: Based on an analysis of Paul Kagan & Associates data.

The future viability of a 10 MHz carrier depends on the projected demand for wireless offerings. At very high levels of demand, a carrier with only 10 MHz of spectrum would have to invest more in additional equipment than a competitor in the same region with 20 MHz of spectrum. This tradeoff point, however, is well in excess of predicted penetration levels of roughly 40 percent over the next several years.[36] Therefore, one 10 MHz block of spectrum in the possession of a rival carrier is sufficient to deter any attempts at monopolization for several years to come.

(5) Falling Entry Barriers

For several reasons, ease of entry undermines the ability of either a single firm to exert market power in wireless services or any group of firms successfully to collude to raise prices. First, to compete in the wireless industry, firms need spectrum, capital, and access to tower sites. Given the rapid advances in transmission technology, spectrum requirements for existing services are now much lower relative to the total amount of spectrum available. Moreover, the amount of spectrum potentially available to wireless competitors could increase beyond the current 180 MHz of cellular, PCS, and

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36. These forecasts are: Yankee Group (37.9%); Paul Kagan (41.4%); Strategis (42.9%); and Dennis Leibowitz of Donaldson, Lufkin, and Jenrette (38.9%).

ESMR spectrum. For example, the lower eighty blocks of ESMR spectrum remain to be auctioned.[37] Second, to our knowledge, there is no evidence of capital market imperfections in the wireless industry. If there were any such imperfections, the FCC's generous bidding credits for designated entities would, if efficacious, have compensated for any borrowing difficulties encountered by small firms. We are not aware of any evidence that those bidding credits failed to work as intended in this respect.

Third, although the costs of building wireless systems to use the available spectrum are not small, technological progress is reducing the total cost of such systems. As Figure 3 shows, the incremental cost of building cell sites has declined steadily for almost a decade.

FIGURE 3: INCREMENTAL COST OF BUILDING CELL SITES
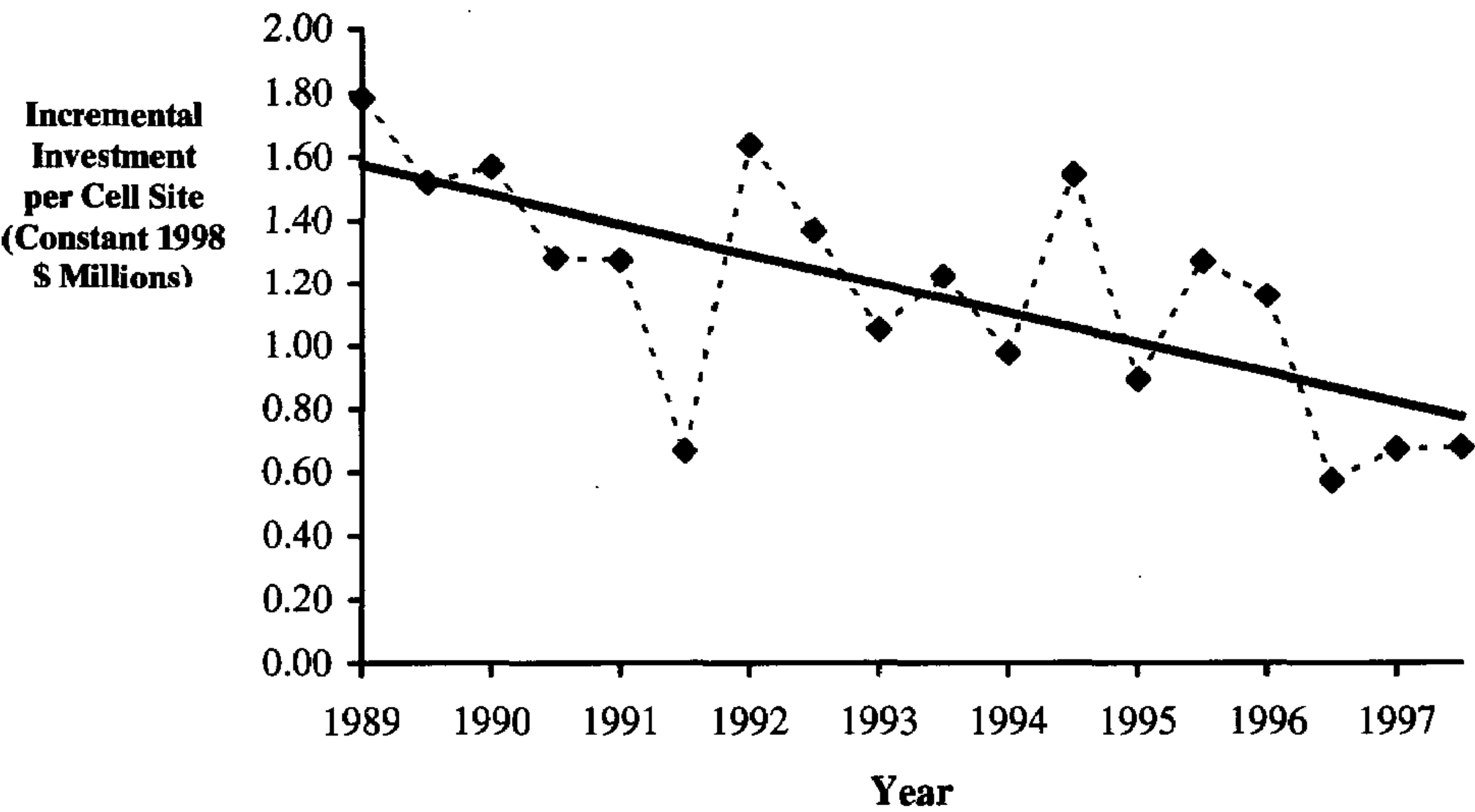
Source: *CTIA Semi-Annual Data Survey (June 1989-June 1998)*.

In addition, the cost of tower siting is becoming less of a barrier to entry. Independent tower management companies—such as American Tower, Omni America, Crown Castle, and TeleCom

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37. In phase I of the ESMR auctions, the Commission licensed the upper 200 blocks of ESMR spectrum. In phase II, the Commission will auction the lower 80 blocks. Federal Communications Commission, *Specialized Mobile Radio (SMR): SMR Upper 200 Fact Sheet*, <http://www.fcc.gov/wtb/auctions> (visited January 18, 1999).

Towers—are becoming important suppliers of tower sites. As a result, entrants can lease these facilities rather than buy sites on their own. Independent cell site operators (ICOs) increase the overall availability of towers by permitting collocation on the same tower of rival operators, making the cell site management function more efficient.[38] ICOs increase the availability of cell sites by removing the incentive of an incumbent carrier to refuse to deal with an entrant.[39] As long as profits for site management continue to grow, one would expect ICOs to facilitate entry into the wireless business.[40] In conclusion, any carrier considering monopolization would have to recognize the competitive threat of potential entrants.

(6) Durable Nature of Spectrum

For attempted monopolization of wireless services to be profitable, a wireless carrier would have to be able to raise prices above current market levels at some future date. Those price increases would have to remain in effect for a nontransitory period and be large enough to compensate the carrier for the profits forgone by holding prices at predatory levels to injure its remaining rivals. Even in the improbable event that a single carrier could drive one of its rivals into bankruptcy, the spectrum of that carrier would remain intact, ready for another firm to buy the capacity at a distress-sale price and immediately undercut the carrier's noncompetitive prices. Thus, the durable, or long-lived, nature of spectrum would serve as a powerful deterrent against any attempts at monopolization. In 1996 the FCC embraced, with respect to newly enacted section 272 of the Telecommunications Act of 1996, the logic of such skepticism toward hypothesized predation by an incumbent local exchange carrier directed toward interexchange carriers operating fiber-optic networks.[41] That conclusion accords with the findings of many respected regulatory economists.[42] If the argument is true for long-

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38. See BRADLEY WILLIAMS, LEGG MASON WOOD WALKER, INC., INDEPENDENT WIRELESS TOWER OPERATORS: REACHING NEW HEIGHTS 15 (1998).

39. For example, Bell Atlantic and BellSouth recently agreed to sell off its towers. See Nicole Harris, BellSouth Corp. Sells 1,850 of Its Towers To Crown Castle in $610 Million Deal, WALL ST. J., Mar. 10, 1999, at B4.

40. For example, U.S. RealTel Inc., a Chicago-based firm that claims to be the nation's largest telecommunications properties landlord, collects between 25 and 35 percent of the rates that it negotiates for tenants. See Jon Van, An Industry Sprouts from Rooftops: RealTel Handles Leasing of Building for Phone Companies' Antennas and Lines, CHI. TRIB., Nov. 19, 1998, at B1.

41. Implementation of the Non-Accounting Safeguards of Sections 271 and 272 of the Communications Act of 1934, as Amended, 11 FCC Rcd. 18,877, 18,943 ¶ 137 (1996) (adopted Jul. 17, 1996) (citing Daniel F. Spulber, Deregulating Telecommunications, 12 YALE J. ON REG. 25, 60 (1995); other citations omitted).

42. See, e.g., PAUL W. MACAVOY, THE FAILURE OF ANTITRUST AND REGULATION

lived fiber capacity, then it holds with even greater force for an *infinitely* durable resource such as spectrum.

(7) Warehousing of Spectrum

Warehousing of spectrum is not a feasible means to monopolize the wireless services industry. As explained earlier, a single carrier could not expect to limit the capacity of its rivals by depriving them of one input in the production process. Second, and perhaps more importantly, warehousing of spectrum is not a profitable endeavor. Any resources devoted toward the hoarding of spectrum could not be deployed in other ventures. The opportunity costs of such behavior would be large, as firms could alternatively invest in such profitable ventures as mobile Internet access. In addition, any urge to warehouse spectrum would be outweighed by the desire to sell the asset for cash. Suppose a firm with 100 MHz of spectrum was considering selling 10 MHz. To the extent that returns to spectrum were decreasing at such high levels, the usage value of the first 10 MHz of spectrum for a spectrum-constrained rival would far exceed the usage value for the warehousing carrier. Thus, to hoard spectrum would entail forgoing an immediate cash flow equal to the difference in those two private values. Moreover, the expense of acquiring spectrum to warehouse is one that the firm incurs immediately, whereas the benefit to the firm (if any) of reduced competition occurs over a number of future periods. Consequently, that stream of anticompetitive benefits must be discounted at the firm's cost of capital to produce a present value that can be compared with the immediate outlay necessary to buy the spectrum to be warehoused. Thus, in addition to being sensitive to all the technological factors that will make spectrum relatively more abundant and capacious in the future, the feasibility of the spectrum warehousing strategy will be sensitive to all the factors that influence the firm's cost of capital. In conclusion, it is unlikely that any firm would attempt to monopolize the wireless industry through warehousing spectrum.

TO ESTABLISH COMPETITION IN LONG-DISTANCE TELEPHONE SERVICES 186–90 (1996); Susan Gates et al., *Deterring Predation in Telecommunications: Are Line-of-Business Restraints Needed?*, 16 MANAGERIAL & DECISION ECON. 427 (1995); Paul S. Brandon & Richard L. Schmalensee, *The Benefits of Releasing the Bell Companies from the Interexchange Restrictions*, 16 MANAGERIAL & DECISION ECON. 349 (1995); Jerry A. Hausman, *Competition in Long-Distance and Telecommunications Markets: Effects of the MFJ*, 16 MANAGERIAL & DECISION ECON. 365 (1995); Kenneth J. Arrow et al., *The Competitive Effects of Line-of-Business Restrictions in Telecommunications*, 16 MANAGERIAL & DECISION ECON. 301 (1995).

B.   The Consumer Welfare Losses Associated with the FCC's Failure to Deter a Single Carrier, or a Group of Carriers Acting Collusively, from Exercising Market Power

It is possible to measure the cost of a Type I error—in the unlikely event that it occurs—by estimating the loss in consumer welfare due to higher prices. Assuming that it offers the same price to all customers, the monopolist will always charge higher prices and produce less output relative to a competitive equilibrium.[43] Monopolization causes consumer surplus—the difference between what consumer would be willing to pay and what they actually pay— to fall in two ways. First, by charging higher prices, monopolization reduces consumer surplus by an amount equal to the product of the change in price and the output under monopoly.[44] Second, by restricting output, monopolization yields a deadweight loss by an amount equal to the area under the demand curve with length equal to the difference in output level between the monopoly and competitive equilibrium.

An estimation of the loss of consumer surplus requires estimates of the demand curve and the price charged by a hypothetical monopolist. Professor Jerry Hausman of the Massachusetts Institute of Technology has estimated the slope of the industry demand curve for cellular services and has found the own-price elasticity of demand to be -0.41.[45] Using this estimate as a proxy for the elasticity of demand for cellular and PCS services, the monopolist's reduction in output can be measured by solving the formula:

$$\eta = \frac{(Q_M - Q_C)/Q_C}{(P_M - P_C)/P_C} = -0.41,$$

where η is the own-price elasticity of demand for cellular and PCS services; Q_M and Q_C are the numbers of subscribers under the monopoly equilibrium and the perfectly competitive equilibrium, respectively; and P_M and P_C are the prices of wireless services under

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43. *See, e.g.,* HAL R. VARIAN, MICROECONOMIC ANALYSIS 283-39 (3d ed. 1992). A price discriminating monopolist will produce the same amount of output as a competitive industry. Thus allocative efficiency is achieved, but the monopolist captures the entire consumer surplus.

44. This component of the loss in consumer welfare is entirely appropriated by the monopolist. Thus, one might argue that it should not be included in a social welfare loss calculation.

45. *See* JERRY HAUSMAN, *Valuation and the Effect of Regulation on New Services in Telecommunications, in* BROOKINGS PAPERS ON ECONOMIC ACTIVITY: MICROECONOMICS, Issue 1 (1997). To estimate the model, Professor Hausman collected price and subscribership data for the period 1989-93 from a confidential survey of cellular operators.

the monopoly equilibrium and the perfectly competitive equilibrium, respectively.

Based on the above formula, it is possible to calculate the loss in consumer welfare associated with various price increases by a hypothetical monopolist. Even in a scenario in which the hypothetical monopolist raises prices substantially, the short-term loss in consumer welfare appropriated by the monopolist would not be large. The portion of consumer welfare that represents the deadweight loss would be substantially less.

More importantly, the *expected* loss in consumer welfare would be miniscule, as any welfare loss must be multiplied by the probability of the Type I error. For example, suppose the loss in consumer welfare is estimated to be L and the probability of the Type I error is estimated to be 0.1 percent. Hence, the expected loss would be $L/1000$. Stated another way, even a $1 million loss in consumer welfare would be converted into only a $1,000 expected loss. We believe that the probability of a Type I error would be vanishingly small because any aggregation of spectrum licenses would necessitate that an application for transfer of control first be filed with the FCC for its public interest review.[46] Moreover, if the acquisition were sufficiently large, the parties would be forced to give premerger notification to the Federal Trade Commission and the Antitrust Division of the Department of Justice for their separate antitrust review under the Hart-Scott-Rodino process.[47] These two reviews, under separate standards, would make it virtually certain that any harmful aggregation of spectrum would be detected before it could be accomplished.

Furthermore, the losses (if any) from a Type I error would be transitory due to regulatory action and market forces. Market forces would drive the industry in the direction of competition. The existence of monopoly rents combined with the low entry barriers described above would induce rival firms to offer service in the region at lower prices.

C. The Enforcement Costs Associated with the FCC's Failure to Deter a Single Carrier, or a Group of Carriers Acting Collusively, from Exercising Market Power

The FCC's elimination of the 45 MHz spectrum cap for CMRS would not mean that providers of wireless services would be free to hoard spectrum for anticompetitive purposes. The antitrust laws would obviously still be enforced, just as the Department of Justice

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46. *See* 47 U.S.C. § 310(d) (1994).
47. *See* 15 U.S.C. § 18(a) (1994).

has previously done in the numerous cases in which that agency has been called upon to scrutinize competition in the wireless industry.[48] Under the Sherman and Clayton Acts, individuals are subject to imprisonment and substantial fines, and corporations are subject to even higher fines.[49] Moreover, the Department of Justice is obviously not alone in its enforcement of the antitrust laws. Private plaintiffs may sue for treble damages,[50] the deterrent effect of which has long been recognized.[51] Finally, injunctive relief is available to correct anticompetitive conduct.[52] In light of these multiple waves of antitrust defense, it is unnecessary for the FCC to defend consumer welfare by prospectively prescribing, through retention of the 45 MHz CMRS spectrum cap, the market structure for wireless communications.

It bears emphasis, however, that even the antitrust laws are a default safeguard against any wireless service provider seeking to monopolize the market or any group of firms seeking to cartelize it. The *first* line of defense against anticompetitive conduct is always the retributive threat of competition itself—from the many large, capable firms that currently provide, or soon will provide, wireless services. Those many firms—which can soon be expected to include a major, new participant from abroad, Vodafone[53]—are not wallflowers. They have significant financial resources, managerial capabilities, as well as brand recognition and reputation.

D. Recapitulation

To summarize, we have shown here in Part II that the expected costs of removing the FCC's 45 MHz spectrum cap are small. The expected cost of removing the cap equals the product of (1) the probability of a large carrier or a cartel of carriers will exert market power within a particular region (that is, the probability of the Type I error) and (2) the sum of the associated loss in consumer welfare and the enforcement costs of remedying that loss (that is, the costs of the Type I error). We have demonstrated qualitatively that the probability of the Type I error is near zero and the associated costs of

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48. *See, e.g.*, Proposed Final Judgment and Competitive Impact Statement; United States v. AT&T Corp. and McCaw Cellular Communications, Inc., 59 Fed. Reg. 44,158 (1994) (proposed July 15, 1994).

49. *See* 15 U.S.C. §§ 1, 2 (1994).

50. *See id.* § 15.

51. *See, e.g.*, Michael K. Block et al., *The Deterrent Effect of Antitrust Enforcement*, 89 J. POL. ECON. 429 (1981); Michael K. Block, & J. Gregory Sidak, *The Cost of Antitrust Deterrence: Why Not Hang a Price Fixer Now and Then?*, 68 GEO. L.J. 1131 (1980); J. Gregory Sidak, Note, *Rethinking Antitrust Damages*, 33 STAN. L. REV. 329 (1981).

52. *See* 15 U.S.C. § 26 (1994).

53. *See* Laura M Holson, *British Carrier Wins Battle for AirTouch, Bell Atlantic Loses Out To a $60 Billion Offer*, N.Y. TIMES, Jan. 16, 1999, at B1.

the Type I error are transitory and small. We next turn in Part III to qualitative assessment of the Type II error, or the efficiency loss that may occur if the minimum efficient scale for some firms exceeds the 45 MHz allowed by the spectrum cap.

III. The Expected Costs of Retaining the Spectrum Cap

Suppose that the future demand for wireless services outstripped the supply capabilities for any single carrier with 45 MHz because of growth in demand for bundled service offerings of voice and data. In that circumstance, some firms might optimally choose to use more than 45 MHz of spectrum to satisfy consumer demand. In this section, we explore the magnitude and severity of the errors that may occur if the FCC interferes with the optimal choice of spectrum by preventing spectrum acquisition over 45 MHz.

A. The Probability that the Minimum Efficient Scale for Some Firms Exceeds the Cap

(1) Landline Displacement by Wireless Services

For two reasons, the future demand for wireless services may require that some providers have more than 45 MHz of spectrum. First, as wireless prices approach wireline prices, fixed (as opposed to mobile) customers will begin substituting wireless telephones for landline telephones. Some evidence today already indicates an interest on the part of wireless carriers to serve fixed customers. As of February 1999, AT&T currently offers digital wireless service in Plano, Texas, in a package designed to attract customers interested in second lines for their businesses or homes.[54] By offering consumers a $40 monthly package of unlimited local calling that is bundled with voicemail, caller ID, call waiting, call forwarding, three-way conferencing, and 10 cents-per-minute long-distance service, AT&T may well position itself to attract second-line customers to its standard wireless service.

The Yankee Group believes that substitution from wireline service to wireless service begins to occur when the wireless-to-wireline price ratio is 3-to-1 or less.[55] The telecommunications research firm points to Israel, Japan, and some Scandinavian wireless markets as examples where landline displacement has occurred.[56]

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54. *See* Jennifer Files, *AT&T to Upgrade its Network; Complaints Prompt Company to Improve Wireless Service* , DALLAS MORNING NEWS, Nov. 13, 1998, at 1D.

55. *See Yankee Group Pricing Study: All-Inclusive Wireless Rates Usher in the Era of Landline Displacement*, PR NEWSWIRE, Jan. 4, 1999.

56. *See id.*

Another recent Yankee Group study that compared wireless and wireline prices in several regions throughout the United States found that migration from wireline service to wireless service begins between 500 and 750 wireless minutes of use (MOU) per month for users on an all-inclusive rate plan.[57]

We have independently calculated the possibility for similar wireless-wireline competition in two other illustrative cities, Dallas, Texas, and Bethesda, Maryland. In both cases, we used the lowest current wireless rate for the average outbound traffic on a residential line in that state and projected that this rate would decline at the same rate as the rate of decline for average PCS prices estimated in 1998 by Donaldson, Lufkin, and Jenrette.[58] We used the current wireline prices, including subscriber line charges, for local and long-distance services. Figures 4 and 5 illustrate the convergence—indeed, the imminent crossover—of wireless and wireline prices in the two regions.

FIGURE 4: CONVERGENCE OF WIRELESS AND WIRELINE PRICES, BETHESDA, MD.

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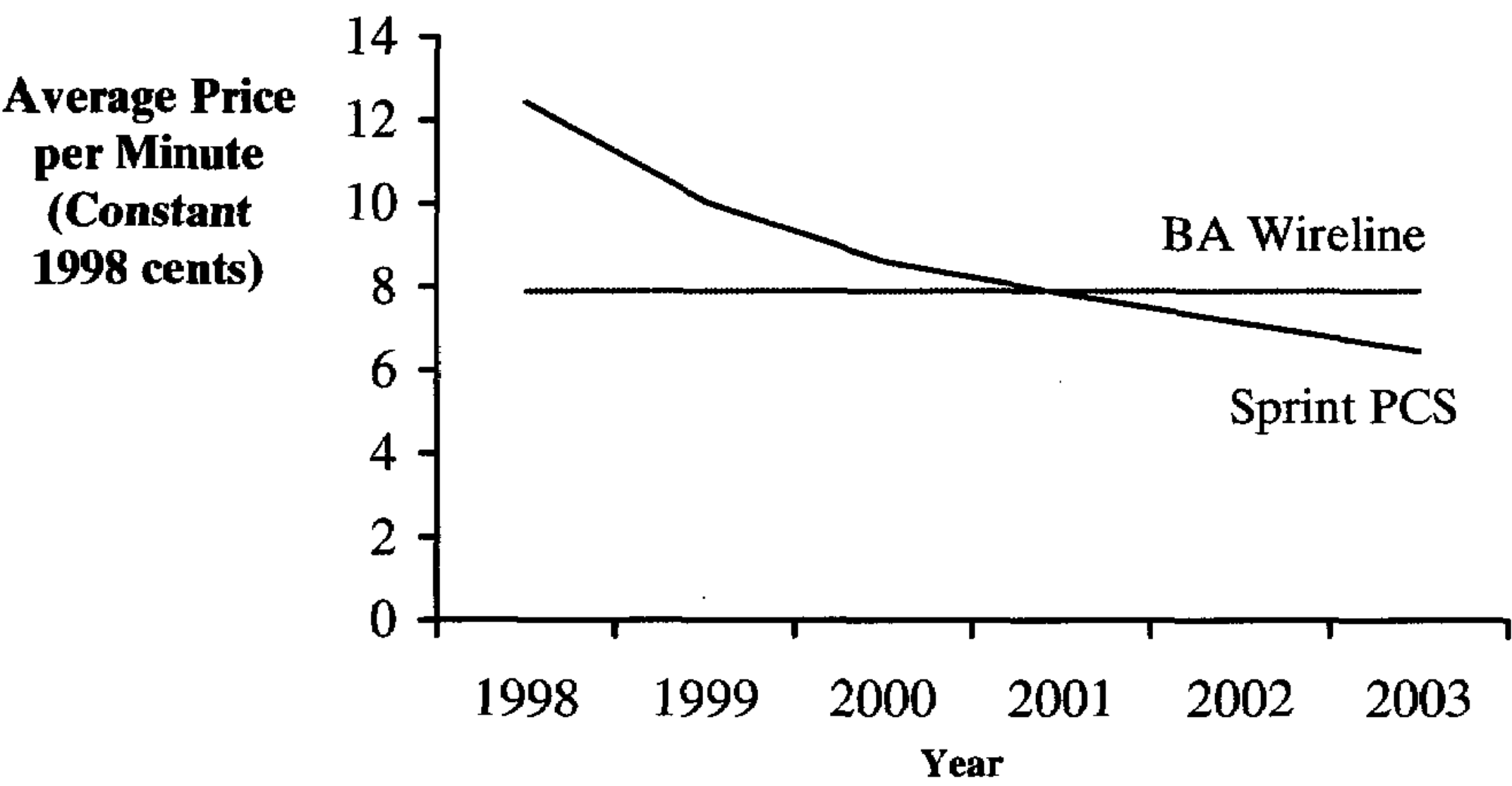
57. *See All-Inclusive Wireless Rates* (visited on Jan. 16, 1999) <http:\www.yankeegroup.com/webfolder/yg21a.nsf/webpress>. Wireless consumers demanding less than 500 MOUs per month would not receive the same price per minute. The study compared the all-inclusive and standard wireless rate plans for local and long-distance wireline rates in eight cities across the United States, including New York, Boston, Dallas, Kansas City, San Francisco, Portland, Chicago, and Miami. The Yankee Group assumed an average 1,000 wireline MOU to reflect the fact that, with the exception of New York City, local wireline rates are unmetered; the Yankee Group then used this average price per minute to compare it with various levels of wireless usage ranging from 60 to 1,200 MOU.

Sources: *Federal Communications Commission, Statistics of Common Carriers, 1996-97 Edition. Bell Atlantic and Sprint rates downloaded from websites at http://www.bellatlantic.com and http://www.sprintpcs.com on Dec. 19, 1998.*

FIGURE 5: CONVERGENCE OF WIRELESS AND WIRELINE PRICES, DALLAS, TX.
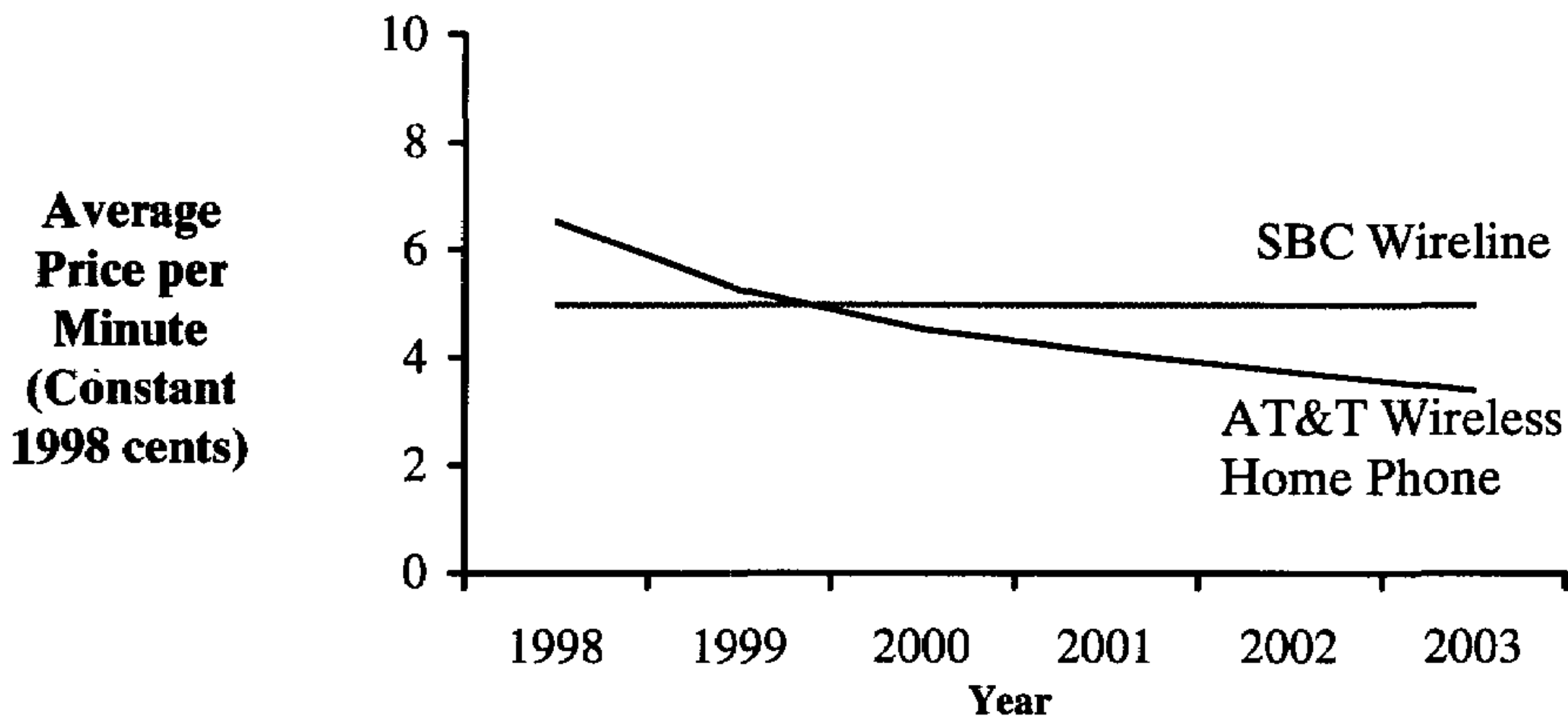
Sources: *Federal Communications Commission, Statistics of Common Carriers, 1996-97 Edition. AT&T Wireless rates downloaded from website at http://www.sbc.com and http://www.attwireless.com on Dec. 19, 1998.*

Figure 5 implies that such substitution will occur in Dallas before the end of 1999. Indeed, at least one recent press report suggests that landline displacement may be occurring in Dallas already.[59]

(2) Consumer Demand for Bundled Offerings of Voice and Data

The minimum efficient scale for some firms may exceed the FCC's 45 MHz spectrum cap due to wireless consumers' increasing demand for bundled offerings of voice and data. According to a recent survey conducted by the Yankee Group, 15 percent of wireless users are very interested in mobile data services, and 36 percent are somewhat interested.[60] Figure 6 shows the forecasted growth in demand for wireless data services. Under its most conservative estimates, the Yankee Group forecasts that the market for mobile

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58. *See* DLJ REPORT, *supra* note 24.

59. *See* Bruce Upbin, *Technology cut the cord,* FORBES, Jan. 25, 1999, at 56.

60. *See* The Yankee Group, *Mobile User Survey Series: The Convergence of Mobile Data and Computing* (visited Aug. 17, 1998). <http://www.yankeegroup.com/>.

data services may grow to 12.59 million users by 2002.[61]

FIGURE 6: U.S. MOBILE DATA MARKET FORECAST
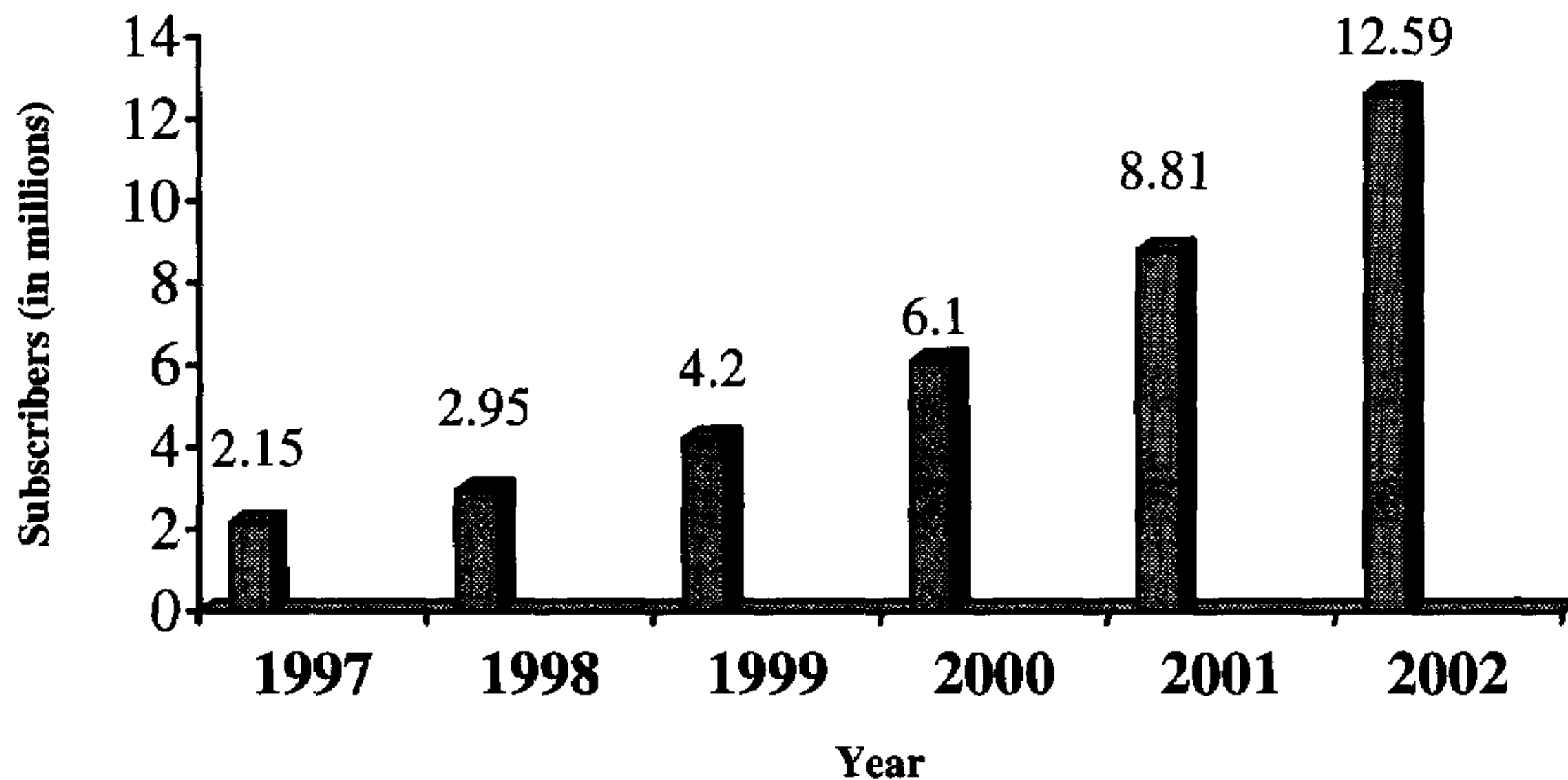
Source: *Information downloaded from Yankee Group website at http://research.yankeegroup.com on January 19, 1999.*

Many industry analysts expect a convergence of voice and data services over wireless platforms. The principal analyst in the mobile and satellite group at Ovum Inc. recently stated that "data is an integral component of the [third generation wireless] vision and will provide a massive expansion of the wireless data opportunity."[62] The Strategis Group predicts wireless Internet and email will become the "killer apps" of the next century.[63] In a 1998 survey, the Strategis Group found that 30 percent of the respondents expressed interest in a "small wireless device that could send and receive e-mail."[64] Another 35 percent were interested in receiving wireless email services over devices "similar to a cellular phone or pager."[65] This is powerful evidence of a growing demand for bundled wireless

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61. *See id.*

62. *Wireless Industry Roundtable Discussion On The Table: The Year in Review And A Look Forward To The Future Of Wireless Data,* WIRELESS DATA NEWS, Dec. 9, 1998, at (remarks of John Davison) [hereinafter *Roundtable Discussion*].

63. *See* The Strategis Group, *Wireless Internet and E-mail Markets: 1998,* at 1 (visited Jan. 19, 1999) <http://www/strategisgroup.com>.

64. *Id.*

65. *Id.*

offerings of voice and data using new third-generation (3G) technology.

There is also evidence that wireless carriers and equipment makers are responding to this demand. BellSouth Wireless recently added data services to its wireless service offerings.[66] Wireless equipment manufacturers previously designed voice and data networks under two distinct architectures. Recently, however, telecommunications equipment companies such as Lucent have begun to unite the architectures for voice and data.[67]

In light of consumers' demand for bundled offerings, the optimal scale of spectrum capacity for some wireless firms may exceed the spectrum cap. We next examine how cost-minimizing firms make optimal input selections and analyze how the 45 MHz spectrum cap may interfere with those decisions.

B. The Social Costs Associated with the FCC's Failure to Allow At Least One Carrier to Use More Than 45 MHz of Spectrum

In January 1999, the Cellular Telephone Industry Association (CTIA) described the 45 MHz spectrum cap as "an impediment to the efficient use of spectrum and the introduction of new services."[68] We describe here three kinds of efficiency losses that would likely arise from the FCC's continuation of the cap. First, the spectrum cap may produce a misallocation of carriers' resources across equipment and spectrum. Second, future competitive alliances may be based more on complying with the FCC's spectrum cap than on maximizing potential synergies. Third, the spectrum cap may deny consumers lower wireless prices that would flow from firms' achieving economies of scale and scope in the delivery of wireless services.

### (1) Allocation of Resources Across Equipment and Spectrum

An artificial regulatory constraint on spectrum capacity can induce a misallocation of resources across equipment and spectrum. Figure 7 depicts the input choices available to a wireless carrier seeking to minimize total costs.

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66. See Roundtable Discussion, supra, note 62 (remarks of Fran Frith).

67. See Lucent Technologies Press Release, Lucent Technologies number one in wireless office (visited Jan 20. 1997) < http://www.lucent.com>.

68. CTIA Faults FCC Wireless Policies as Anticompetitive, MOBILE COMM. REP., Jan. 11, 1999, at *1.

FIGURE 7: OPTIMAL ALLOCATION OF EQUIPMENT AND
SPECTRUM FOR A COST MINIMIZING FIRM
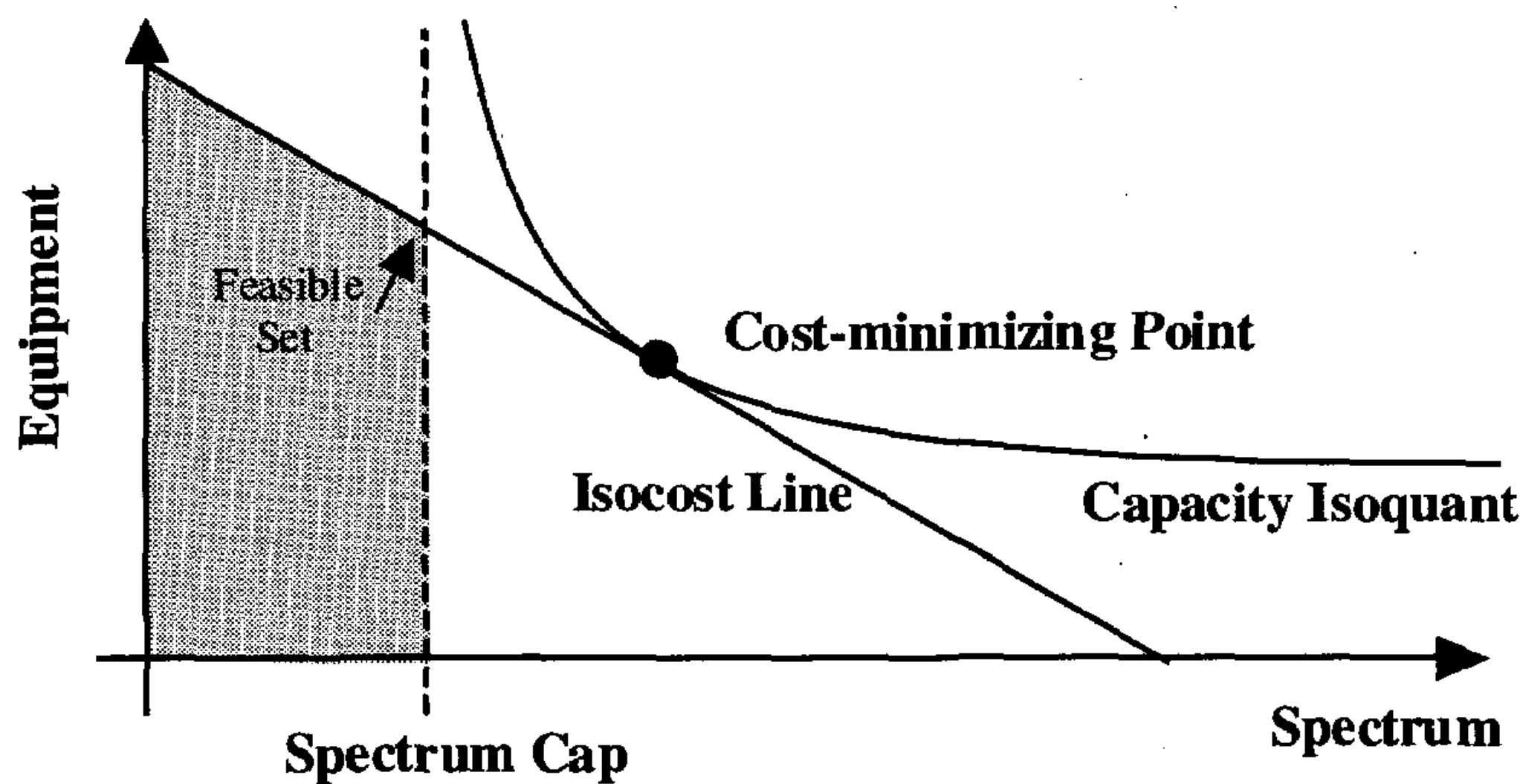
The curved labeled capacity *isoquant* represents all the combinations of spectrum and equipment that would yield the same level of capacity for the firm. The line labeled *isocost* line represents all combinations of spectrum and equipment that would yield the same level of total expenditures for the firm. A cost-minimizing firm chooses to combine the inputs in such a way that the ratio of input prices equals the ratio of marginal factor productivities. Geometrically, this is equivalent to finding the point of tangency between the isocost and isoquant. As Figure 7 shows, a firm facing this particular technological tradeoff and these particular input prices would naturally choose more spectrum than the FCC's cap allows. Any deviation from the optimal, cost-minimizing point represents a loss in productive efficiency. Due to the constraint imposed by the FCC's 45 MHz spectrum cap, a firm could achieve a greater amount of capacity while not increasing its total expenditures by substituting away from equipment—that is, by trading equipment for spectrum at the current level of input prices.

(2)   The Optimal Scope and Scale of the Firm

There are likely great economies of scale and scope in the provision of advanced mobile data services. First of all, high-speed data services will likely consume large amounts of bandwidth. The required throughput is higher than voice to begin with, and compression is less effective on data streams (which are likely to be already compressed at their source) than it is on the pattern-rich human voice. Second, offering a high-speed data capability is likely to be an all-or-nothing decision. That is, there may be no such thing as a minimal data offering. If a carrier were not to offer high-speed data at

an intensive scale throughout a particular market region, it would likely suffer the same fate of the current data protocols, which have struggled to gain user acceptance and build sufficient penetration to justify the necessary investment.[69]

Second, there are likely great economies of scope between the provision of advanced data services and traditional voice-grade services over the same wireless network. The data services would likely share the same towers and other structures (for example, power supply housings), the same backhaul transport routes, and potentially the same antennas. Operators could then achieve other economies of scope by marketing and billing these two types of services jointly. Therefore, the development of advanced data services could lower the costs of providing traditional voice-grade mobile service.

Although we do not know now what the optimal spectrum bandwidth will be for the provision of advanced wireless data services, it may well be far in excess of the current 45 MHz spectrum cap. One can envision the need for greater raw bandwidth using a simple calculation. Suppose that an operator can satisfy future voice demand with 10 MHz of spectrum. If 20 percent of the operator's customers demanded mobile high-speed data with a 384 kbps average throughput (twenty times the current voice-rate throughput), as a rough approximation the raw bandwidth required would need to increase to 480 percent of the original, or 48 MHz = (.20 x 20 + .80 x 1) x 10 MHz. Even more bandwidth would be required if customers were to demand mobile T1 equivalents (with a data rate of 1.5 Mbps).

(3) Investment and Innovation

The FCC desires that its policy toward the CMRS spectrum cap "promotes, rather than impedes, the introduction of innovative services and technological advances."[70] Unfortunately, the spectrum cap may retard investment and innovation through myriad effects. First, wireless service providers must compete with other industries for capital. To the extent that the spectrum cap prohibits wireless carriers from operating in the most efficient manner, investors will commit their capital elsewhere. Second, the cap may lead companies to delay entry. If the minimum efficient scale exceeds the cap, potential carriers may strategically delay entry until the cap is lifted. Third, the cap may inhibit exit from the wireless industry. With the cap in place, a 30 MHz firm may be forced to find two or more buyers, as the potential acquirer may be close to the cap itself. Future entrants would rationally anticipate the "exit problem" and would

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69. *See* Aldo Morri, 3G *Migration: Waiting for the Wave*, WIRELESS REVIEW, at *1.
70. *Spectrum Cap NPRM, supra* note 5, ¶ 5.

therefore be less willing to enter and invest ex ante.[71]

C. The Enforcement Costs Associated with the FCC's Failure to Allow At Least One Carrier to Use More Than 45 MHz of Spectrum

If the 45 MHz spectrum cap becomes a binding constraint on carriers' optimal spectrum utilization, the equilibrium scale of carriers in the face of the cap will be less than socially optimal. Barring the removal of the spectrum cap, the FCC would be forced into the undesirable position of conducting a separate wireless data services auction. This option would entail substantial transactions costs (such as determining which portion of the spectrum to sell, conducting bidder seminars, and conducting the auction) and directly contradict the FCC's prior objective of not dictating how spectrum should be used. In addition, the artificial bifurcation of wireless voice and data delivery would deprive consumers of the potential savings that could be realized if carriers could offer voice and data over the same spectrum. Retention of the spectrum cap would also entail administrative costs tied directly to compliance with the cap. These costs would include costs imposed on a carrier in attempting to determine compliance and, in the event of an inability to comply under its business plans, formulation of alternatives. The FCC would incur corresponding administrative costs.

IV. The Expected Costs of Retaining the Cap Exceed the Expected Costs of Removing It

We can envision either of two alternative scenarios developing in the wireless service industry, each of which would require the FCC's abolition of the 45MHz spectrum cap. First, the wireless market could divide into various niches, with some firms serving voice only, data only, business only, or some combination of the three.[72] Second, the demand for bundled services could be so strong that the only way for a firm to compete effectively would be to aggregate more than 45 MHz of spectrum.

In the first scenario, where the industry splits apart into various niche offerings, 45 MHz would be insufficient for the subset of firms

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71. It is well recognized that a barrier to exit becomes a barrier to entry. *See* WILLIAM J. BAUMOL ET AL., CONTESTABLE MARKETS AND THE THEORY OF INDUSTRY STRUCTURE 6-7 (1988).

72. This phenomenon may already be occurring. For example, Cellular One does not appear to be following the same pricing strategies of its competitors in the Washington, D.C. area. Rather than reducing prices across for all levels of usage, Cellular One is offering additional lines for family members with free weekend airtime. Perhaps this strategy is an indication that the wireless market will segment into business and family usage.

wishing to provide bundled services or to invade the fixed-services market. A single 10 MHz carrier providing voice services alone could still provide the pricing discipline necessary to defeat any attempt at monopolization by a multiproduct firm or any attempt at cartelization by multiple firms. The marginal customer would abandon the bundle of services in the face of excessive prices because, for that customer, the voice-only applications would be substitutes for those bundled services.

In the second scenario, where the demand for bundled services overwhelms existing capacity, all firms would require more than 45 MHz to supply services efficiently. Hence, a single 10 MHz carrier could not exert pricing discipline in the face of attempted monopolization or cartelization. But in this second scenario, the FCC's entire regulatory framework for CMRS spectrum would rest on the misconception that the 45 MHz spectrum cap was not a binding constraint on the efficient production of wireless services. Confronted with that erroneous premise, the FCC would need to allocate additional spectrum so that multiple firms could efficiently produce services under the new competitive paradigm. Thus, under either scenario, the FCC would be better served by removing the cap.

Regardless of whether some or all firms would optimally choose to employ more than 45 MHz, the FCC's retention of the 45 MHz spectrum cap would thwart one of the principal functions served by market forces—namely, to produce and reveal information.[73]

If the spectrum cap were eliminated and a Type I error occurred, the FCC at least would become aware of the problem and could take steps to remedy the harm to the public interest. In contrast, if the spectrum cap were retained and a Type II error occurred, it is possible that the FCC would never learn that it was preventing the optimal input selection of wireless firms. Such information is extremely valuable for the FCC to have at its disposal, as it would assist the agency in redefining its spectrum allocation policy in the manner most conducive to the public interest.

The goal for which the FCC devised the 45 MHz CMRS spectrum cap has been achieved. The cap should now be abolished. The probability that a single carrier, or a group of carriers acting

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73. As one of us has previously observed:
    Competition is the best mechanism for stimulating research and development and for resolving uncertainty about evolving technology. Technological change and uncertainty surely characterize the telecommunications industry. As Friedrich A. Hayek powerfully argued, markets create and process vast quantities of information, which necessarily would overwhelm the conscious efforts of any central economic planner.
SIDAK & SPULBER, supra note 1, at 523 (citing Friedrich A. Hayek, The Use of Knowledge in Society, 35 AM. ECON. REV. 519 (1945)).

collusively, could exercise market power in a given geographic region is remote, while the corresponding harms are relatively minor. Meanwhile, the probability that the minimum efficient scale for at least one firm exceeds the spectrum cap is nontrivial, and the resulting loss in efficiency is potentially large. In short, the expected costs of retaining the cap exceed the expected costs of removing it. Thus, the FCC would advance the public interest by abolishing the cap.

V. The General Applicability of the Decision-Theoretic Framework

The decision-theoretic framework that we have applied to the 45 MHz CMRS spectrum cap can be generalized to address a broad range of competitive policy issues in the wireless telecommunications industry. In most competitive policy matters, regulators must strike a delicate balance between anticompetitive concerns and potential gains in efficiency and innovation. We can broadly define the Type I error as the regulator's failure to deter a harmful event. In contrast, the Type II error can be broadly defined as the regulator's failure to allow a beneficial event. Define p as the probability of a Type I error, q as the probability of a Type II error, L_I as the losses associated with a Type I error, and L_{II} as the losses associated with a Type II error. Figure 8 demonstrates the decision tree.

FIGURE 8: DECISION TREE FOR COMPETITIVE POLICY
ANALYSIS
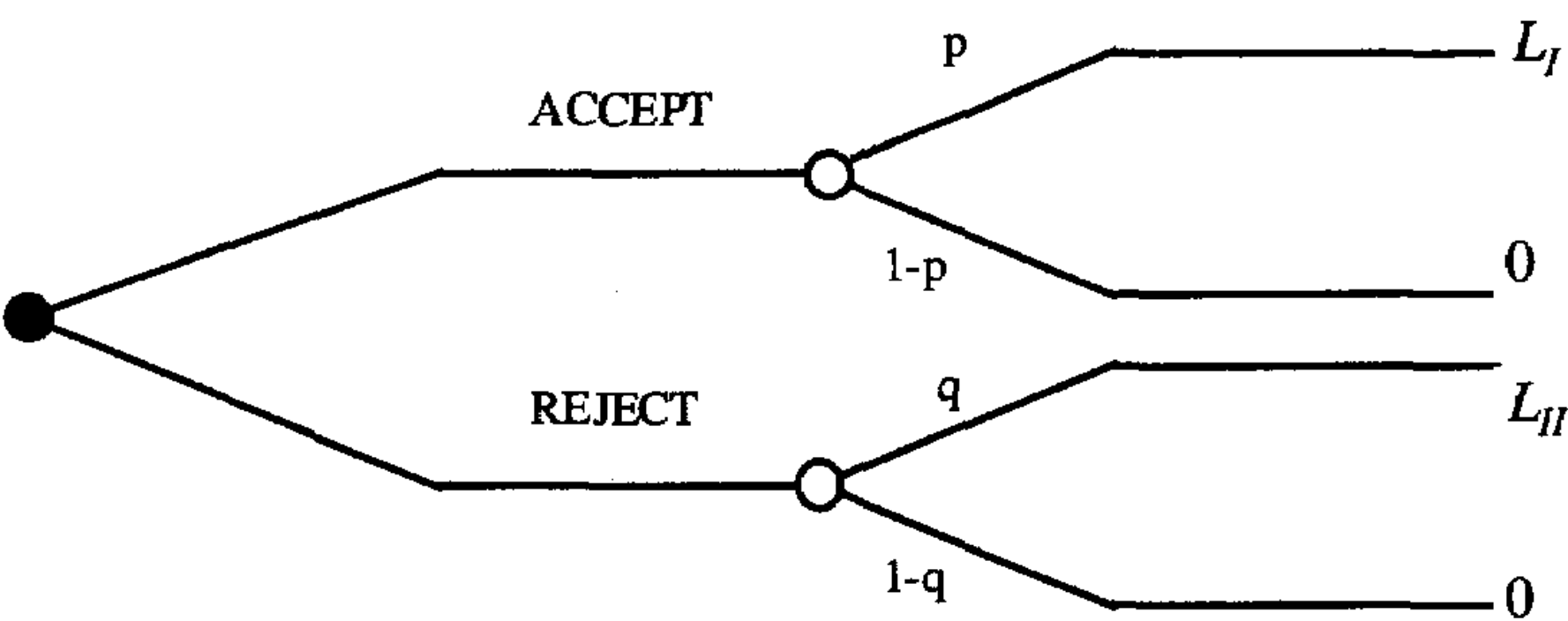
The darkened node represents the stage at which the regulator decides to accept or reject a policy. The lightened nodes represent the stage at which "nature" decides whether the Type I or Type II error occurs. As Figure 8 shows, the regulator must weigh the expected loss of the Type I error against the expected costs of the Type II error. The decision rule simplifies to "accept the policy if the $pL_I \le pL_{II}$."

The decision rule can be applied to a broad class of competitive issues in the wireless industry. For example, suppose two wireless firms were considering a merger that would result in the reduction of a competitor in at least one geographic region. In this case, the policy issue is whether or not the merged firms should be forced to divest its wireless licenses in the overlap territories. According to the decision-theoretic framework, the merged firms should be forced to divest if the expected costs of allowing the firms to retain the properties exceed the expected costs of forcing the firms to divest.

The expected costs of allowing the merged firms to retain the properties is the product of (1) the probability that the merged firms will exert market power within a particular overlap region and (2) the sum of the associated loss in consumer welfare and the enforcement costs of remedying that loss. The expected costs of forcing the firms to divest the properties is the product of (1) the probability that the merged firms could reduce its costs through economies of scope and scale and (2) the sum of the efficiency losses and the enforcement costs of remedying those efficiency losses. The calculation of the expected costs in this instance can be performed in identical fashion to the spectrum cap application.

Fortunately, many of the same factors that influence the decision process in the spectrum cap rule resurface in the divestiture matter. The probability that the merged firms will exercise market power within an overlap region is largely a function of competition in the wireless services industry, the existence of nationwide competitors, the availability of capacity-expanding equipment, falling entry barriers, the durable nature of spectrum, and the efficacy of warehousing spectrum. The loss in consumer welfare resulting from an exercise of market power is a function of the elasticity of demand for wireless services. Likewise, the probability that the merged firms will be able to reduce costs by taking advantage of economies of scope and scale is a function of growing demand for wireless data applications and increasing landline penetration. The loss in efficiency depends on wireless firms' production technologies.

Because the aforementioned factors are identical to those used in the spectrum-cap decision analysis, the results of the merger analysis should approximate the results derived above, namely, a small probability that the merged firms will exert market power, a small loss in consumer welfare resulting from the exercise of market power, a nontrivial probability that the merged firms will not be able to achieve economies of scope and scale but for the divestiture of overlap licenses, and a large loss in efficiency resulting from the divestiture. Furthermore, because those factors are not specific to any one region or firm, one would expect the calculations to be the same for a broad range of merger possibilities. Therefore, barring any

dramatic change in the underlying factors, the application of the decision rule would likely demonstrate in most merger scenarios that the expected costs of forcing the merged firms to divest will exceed the expected costs of allowing the merged firms to retain licenses in overlap territories.

Conclusion

Application of decision-theoretic analysis reveals the expected costs of retaining the FCC's 45 MHz spectrum cap exceed the expected costs of removing it. The expected cost of removing the cap is the product of (1) the probability that a single carrier, or a group of carriers acting collusively, could exercise market power and (2) the sum of the associated loss in consumer welfare and the enforcement costs of remedying the loss. The expected cost of keeping the spectrum cap is the product of (1) the probability that the minimum efficient scale for at least one firm exceeds the spectrum cap and (2) the sum of the efficiency losses and the enforcement costs of remedying those efficiency losses.

Our conclusion, grounded in competitive analysis and decision theory, is consistent with the FCC's belief that "trusting in the operation of market forces generally better serves the public interest than regulation."[74] The probability that a single carrier, or a group of carriers acting collusively, could exercise market power in a given geographic region is remote, while the corresponding harms are relatively minor. Meanwhile, the probability that the minimum efficient scale for at least one firm exceeds the spectrum cap is nontrivial, and the resulting loss in efficiency is potentially large. Thus, the FCC would advance the public interest by abolishing the cap, because the expected costs of retaining the cap exceed the expected costs of removing it.

Of all the trends that we have identified in the wireless industry, none is more significant from a competition policy perspective than landline displacement by wireless services. The increasing substitutability of wireless and wireline services is blurring the definitions of the relevant product market in the telecommunications industry. When regulators or antitrust enforcers or courts assess the market power of a fixed service provider, they must now ask whether an increase in the price of fixed service will result in the marginal customer selecting a competitive wireless carrier. Likewise, when a regulator sets the price that an incumbent local exchange carrier may charge to lease an unbundled network element to competitive local exchange carriers (CLEC), one must ask how much it would cost the

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74. *Spectrum Cap NPRM, supra* note 5, ¶ 5.

CLEC to serve the same customers with a wireless network. Wireless service providers are telecommunications firms that need not wait for regulators to resolve the contentious issue of unbundling.