of advanced services such as virtual private networks. The long-distance carriers have been active in the development of technologies to facilitate the transmission of data via long-distance networks. Key innovations include frame relay packet-switching service and switched multi-megabit data service.[19]

In summary, real prices for long-distance services have declined more rapidly than access charges, which is consistent with the view that long-distance services are increasingly competitive. This interpretation is further supported by the history of product innovation, quality improvement, entry, and investment in new facilities, which have characterized the performance of long-distance services since divestiture in 1984.

IV. Paul MacAvoy's Analysis of Competition in the Long-Distance Industry

Paul MacAvoy has recently offered a sweeping criticism of the viability of competition in various markets for interLATA long-distance services. In his words:

> These findings conclusively show that AT&T, MCI, and Sprint have not set prices for interLATA services competitively. To the contrary, these three firms have developed market sharing and identical pricing patterns to an extent that results in a classic case study in tacit collusion. Eliminating the MFJ's interLATA restriction and permitting the Regional Bell Operating Companies (RBOCs) to compete against the current pricing arrangement of the inter-exchange carriers could only move markets toward competition and increase consumer welfare.[20]

Substantively, MacAvoy's principal conclusions were three. First, interexchange markets have

---

[19] Michael Porter offers numerous illustrations of the pace of innovation in long-distance telecommunications; see Porter, note 1, *supra*.

[20] See *Affidavit* of Paul W. MacAvoy, note 11, *supra*, page 3, paragraph 6.

been highly concentrated since the 1984 divestiture. Second, recent stability in market shares for AT&T, MCI, and Sprint facilitated tacit collusion and noncompetitive pricing. Third, price-cost margins for long-distance services increased after 1990, despite stabilizing market concentration, and differences across markets in price-cost margins have followed a pattern consistent with tacit collusion. These conclusions are supported by a selective and, in some instances, misleading presentation of the recent history of the performance of long-distance markets and of the theoretical framework through which one might study that performance.

We discussed earlier the inadequacy of conventional measures of concentration as indicators of potential market power in this industry. With respect to MacAvoy's second conclusion, we already noted that market share data, taken in isolation, mask significant customer churn. Accordingly, we focus our attention on MacAvoy's measurement and analysis of price-cost margins and other measures of current and prospective profitability in the long-distance industry. In particular, we describe and analyze: errors in the measurement and construction of price-cost margins in MacAvoy's study, problems with the theoretical framework used by MacAvoy, properly revised trends in margins, difficulties in interpreting MacAvoy's evidence on tacit collusion, and criticisms of his examination of financial market measures of profitability.

A. MacAvoy's Analysis of Price-Cost Margins

MacAvoy's construction of price-cost margins is misleading. The concepts of "price" and "cost" in the price-cost margin refer to marginal transactions prices and incremental costs. MacAvoy's price data do not reflect marginal transactions prices, as they ignore the effects of

discounting and promotional programs. His assumptions about traffic patterns do not match actual patterns. His data on costs incorrectly account for access charges, are likely to understate incremental network costs, and do not incorporate incremental costs required to solicit marginal customers.

Problems in Defining Prices. MacAvoy systematically overstates actual prices by relying on tariff data instead of the more meaningful data on average revenue per minute. For example, MacAvoy's principal source of price data for AT&T's residential service is AT&T's MTS service (MacAvoy Table 2, Appendix), which he converts into an "average price per minute" based on unsupported traffic assumptions which result in inflated estimated prices (reported in MacAvoy Table 1, Appendix). He assumes, for example, that 50 percent of all MTS calls are for distances of more than 926 miles, and 85 percent occur during peak calling periods; however, AT&T proprietary data indicate that these estimates consistently overstate the percentages of longer-distance and peak-period calls.[21] Because longer-distance and peak-period calls are priced at higher rates, MacAvoy's traffic assumptions are biased toward finding a high price-cost margin.[22] In addition, because he assumed that there is a common traffic

---

[21] The extent to which MacAvoy's assumptions lead to an overstatement of the cost of residential calls is magnified by assuming that the mileage distribution does not vary by time of day. Because rational consumers tend to postpone their most expensive long-distance calls to off-peak periods, this overstates the prices actually paid. MacAvoy's assumptions also overstate the prices paid by business callers.

AT&T's traffic distribution for interstate MTS calls is set forth in Table 3 in the Confidential Appendix.

[22] For example, using AT&T's MTS tariff (September 15, 1994), MacAvoy's assumptions result in an average tariff price of $0.249 per minute. If one uses AT&T's actual traffic distribution, the estimated average tariff price is between $0.176 and $0.239 per minute. These estimated "average tariff prices" are computed using AT&T's Dial Station rates from F.C.C. Tariff No. 1, which are as follows (see 71st revision, page 56, September 15, 1994, Sec 3.2.1

distribution which applies to all carriers and all services and does not vary by time of day nor year to year, MacAvoy distorted the estimates of service-specific price trends. For example, one might expect traffic distributions across carriers to reflect differences in prices, marketing strategies, and the mix of customers, which implies that using the same distribution for all carriers would distort average industry tariff prices. Without more data on traffic distributions over time for AT&T, Sprint, MCI, and the other carriers, it is impossible accurately to determine the magnitude of the upward bias incorporated in MacAvoy's estimates of tariff trends.[23]

We can, however, offer an indication of the likely severity of the bias. When the FCC reports comparative price data, it reports the prices of calls for a number of different city pairs and for a variety of time periods and call durations in recognition of the difficulties inherent in

---

(L.1)):

	Cents per minute		
Mileage	Day	Evening	Night/Weekend
0-55	0.24	0.13	0.12
56-292	0.25	0.16	0.12
293-430	0.26	0.16	0.12
431-925	0.27	0.16	0.14
926-1910	0.27	0.17	0.14
1911-3000	0.27	0.17	0.14

The revised estimates of MacAvoy continue to overstate actual prices because they ignore discount programs and do not reflect changes in mileage distributions by time of day.

[23] Michael Porter's study (see note 1, *supra*) provides ample evidence of the diversity of new services and tariff filings since 1984; see especially Exhibits 7, 11, 12, 13, 14, 15, and 16. As another measure of tariff complexity, we note that, during the first half of 1994 alone, AT&T filed 9,511 pages of tariffs in the "switched service" category, 14,132 pages in the private line service category, and 13,732 pages in the custom service category.

comparing tariffs across services, across carriers and across time.[24] For example, while MacAvoy reports AT&T's MTS average price per minute of residential service for 1992 as $0.2279 (January 2, 1992) and $0.2270 (June 1, 1992), the FCC data report 1992 prices for AT&T ranging from $0.25 (for a five-minute, daytime call between New York and San Francisco) to $0.12 (for a five-minute, night/weekend call between New York and Philadelphia). Unfortunately, there is no simple way to compare carrier tariffs without carefully considering such issues as differences in discount and promotional programs and customer calling patterns, which differ both by region and by customer segment. Although long-distance customers are provided with information about their own traffic patterns, thereby facilitating comparison shopping, detailed traffic distribution data across all services and all carriers are not readily available. Therefore, tariff information *per se* is not particularly useful for evaluating long-distance pricing trends.

MacAvoy's use of tariff data is especially misleading if one is trying to determine the extent of price *competition* in the long-distance market, because these data do not reflect the aggressive promotional programs and price discounting programs being offered to both large and small customers.[25] A more reliable summary statistic of the prices which consumers are

---

[24] See Federal Communications Commission, *Statistics of Communications Common Carriers, 1992/1993 edition*. Washington, D.C., 1994, Table 7.4, pp. 286-297.

[25] The competitive battle for long-distance is so intense it has even been profiled in the popular press. From *USA Today*, September 23, 1994, page 1B:

> Long distance carriers are using heavy artillery in their exhaustive battle for long distance callers, and customers are caught in the cross-fire. AT&T, MCI and Sprint have escalated their marketing war far beyond even the Coke vs. Pepsi level.... AT&T spent about $250 million last year advertising just to home consumers. MCI spent $140 million. Sprint, about $80 million... This year, ad spending by the Big Three long distance giants is running well ahead of last year's pace. The advertising blitz — and all

actually paying in the market is provided by AT&T's average revenue per minute. These actual prices are significantly lower than the tariff prices used in MacAvoy's analysis -- as a comparison of MacAvoy's tariff prices with the average revenue per minute figures shown in Table 2 in the *Confidential Appendix* demonstrates. A recent study by the WEFA Group,[26] on which MacAvoy relies for his estimate of costs, reports AT&T's average revenue per minute at $0.18 per minute in 1992, a figure substantially less than MacAvoy's "price" estimate.

Problems in Defining Costs. In addition to selecting prices that overstate the actual prices paid by AT&T's actual customers, MacAvoy's estimate of incremental costs are also too low [27]

> the marketing pitches — has fueled a dash to and from the long distance firms: 40,000 people a day switch carriers. Phone companies are also preparing to offer information-highway era services soon, including wireless calling and advanced networks to let you send and retrieve voice, text and video programming.... Already, long distance companies are pitching add-on services, such as messaging and special calling cards.... All are planning to roll out 1-500 services, which will give people one number that will "find them" by ringing several locations: home, office, car or portable. AT&T completed its $11.5 billion purchase of McCaw Cellular this week and plans to offer cellular calling under the AT&T brand within 18 months. One likely tie-in: AT&T probably will award free wireless talk time to its heavy long distance callers, through its True Rewards program...

[26] WEFA Group, *Economic Impact of Eliminating the Line-of-Business Restrictions on the Bell Companies*, July 1993.

[27] MacAvoy's measure of access charges is inconsistent with his approach to measuring prices. In defining "price," MacAvoy inappropriately used (an element of) tariff prices, thereby overstating true marginal prices. If one accepts that approach, a more appropriate measure of "access cost" is the tariffed access cost. (The choices of tariff prices and actual access costs, of course, biases upward the estimated price-cost margin.) Actual access charges reflect both reductions in tariffed charges and changes in the mix of access facilities purchased by the long-distance carriers. With access charges that are still significantly above the costs of providing access services and faced with aggressive competition, competitors have been encouraged to invest in cost reductions that optimize the use of local-access facilities (*e.g.*, by relocating POPs closer to the local exchange carriers and by pursuing attempts toward network realignment). These productivity enhancements, of course, show up as lower access charges paid, an additional sign of the effectiveness of long-distance competition

There are a number of problems with his approach.[28]

First, MacAvoy incorrectly accounts for access charges. The estimate of access charges used by MacAvoy[29] is based on data reported in the FCC's *Statistics of Communications Common Carriers, 1992-1993 Edition*, Tables 6.2 and 8.9. Specifically, he divides "Interstate Access Revenues" (item 508, Table 6.2) by "Total Interstate Switched Access Minutes" (Table 8.9) to compute an average access charge per minute for each year from 1985 through 1992; he uses WEFA's estimate of $0.055 per minute for 1993. The revenue number he uses includes the subscriber line charges paid by customers directly to the local-exchange carriers, thereby overstating the access charges incurred by carriers. (The error is partially offset by the fact that the revenue number only includes data for Tier 1 carriers, whereas the estimate of access minutes includes data for all carriers.)[30] A more important problem is evident from MacAvoy's method for converting estimates of access charges *per access minute* into an incremental access charge *per conversation minute*. MacAvoy assumes that there is one access minute per conversation minute and uses the same incremental access cost for all services. Once again, this is an oversimplification which understates incremental costs and overstates price-cost margins.

An alternative source of data on access charges which indicates the complexity of

---

[28] In addition to the conceptual problems we examine below, the lack of available data for all services and carriers does not permit one to estimate service-specific incremental costs for such categories as network capital and maintenance, fraud and sales and marketing.

[29] See *Affidavit* of Paul W. MacAvoy, note 11, *supra*.

[30] Moreover, even if this estimate were correct, it would only apply to interstate toll service since intrastate, interLATA toll service incurs intrastate access charges which are typically higher.

estimating incremental costs is provided in Table 5.11 (page 386) of the *Monitoring Report* (CC Docket No. 87-339, May 1994) prepared by the staff of the Federal-State Joint Board. This table provides an estimate of total access charges *per conversation minute* which varies from over $0.166 per minute in 1985 to $0.067 per minute in 1993, as compared to MacAvoy's estimates which range from $0.104 per minute in 1985 to $0.055 per minute in 1993. The *Monitoring Report* estimate is appropriate for switched long-distance services which incur access charges on both the originating and terminating ends.[31] The appropriate incremental access charge will vary by type of customer service.[32] The magnitude of the differences among services are shown in the revised estimates of incremental access costs included in Table 1. For example, MacAvoy understates access charges for long-distance residential and business MTS (Basket 1) and overstates access charges for 800 and other business outbound services (Baskets 2 and 3) by $0.01 per conversation minute, an error in excess of 18 percent in 1993.

In addition to underestimating access charges, MacAvoy underestimates incremental network costs. According to MacAvoy:

> Incremental expenses are those associated with small changes in total service levels.... WEFA estimates that average incremental costs of long-distance service equal $0.01 per minute, whereas Bellcore estimates that these costs are approximately $0.005 per minute, according to its Network Cost Analysis Tool.... Choosing the more conservative

---

[31] Actually, there are on average 1.07 originating access minutes and one terminating access minute for each conversation minute. This adjustment corrects for the fact that the long-distance carrier is billed for the time it takes to set up the call and for calls which are not completed, even though the customer does not pay for these charges (see the notes to Table 5.11 in the *Monitoring Report*).

[32] For example, WATS customers incur special access charges on the originating end only, while private line customers pay special access on both ends. For services such as 800, switched charges are incurred on the originating end and either special access or switched charges on the terminating end may be incurred, depending on the type of 800 service.

estimate, from WEFA,..."[33]

WEFA did not prepare separate estimates of network costs, but merely relied on the estimate provided by the Bellcore model. Although AT&T requested an explanation of how the model works, as well as a listing of the model's assumptions and results generating the above estimates, such information was not provided. Indeed, the WEFA study simply rounds upward the Bellcore estimate without justification beyond the claim that the authors wish to appear conservative. This unsubstantiated adjustment is especially troublesome in light of both WEFA's and MacAvoy's failure to describe traffic assumptions adequately. Costs vary with distance, duration, and time of day on account of congestion patterns and other link-specific characteristics. When the network is congested, incremental capacity costs estimated in a network capital planning model may be significantly higher than the $0.01 used by WEFA. An alternative study prepared by AT&T's Bell Laboratories, which examined the incremental costs of lighting dark fiber for MCI and Sprint in order to capture AT&T's long distance traffic, arrived at an estimate of incremental network capital costs of $0.023 per minute.[34] Regardless of which estimate one uses, both costs should be expanded to account for the incremental network operating costs associated with maintaining the expanded capacity, which could add another $0.005 per minute.[35]

---

[33] See MacAvoy, note 11, *supra*, paragraph 60.

[34] See V.A. Blake, P.V. Flynn, and F.B. Jennings, "A Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," Bell Laboratories, August 4, 1989.

[35] According to AT&T's 1993 Form M, maintenance expenses for Central Office Switching ($354 million), Central Office Transmission ($438 million), and Cable and Wire ($262 million) totaled $1.054 billion. Assuming that only 87 percent of this expense is associated with switched long-distance services (*i.e.*, the share of switched revenues reported in the Form M), this corresponds to an incremental cost of approximately $0.005 per conversation minute, based on

MacAvoy assumes that the network costs are not changing over time, in spite of the fact that since 1984 the long distance carriers have been investing heavily to increase the quality and lower the operating costs of their networks. Also, MacAvoy assumes that all of the carriers face identical incremental costs. Although MCI, Sprint, and AT&T have access to similar technologies, their networks are not identical and hence incremental capacity costs are likely to differ. For example, AT&T's network costs are affected by having inherited a disproportionate share of low-volume customers from the former Bell System.

Finally, even if one accepts MacAvoy's estimate of $0.01 per minute of incremental network costs, such an estimate does not reflect a full accounting of incremental costs.[36] MacAvoy neglects to include production-sensitive customer-related marketing costs. Such costs are not fixed, and are sensitive to changes in the number of customers and calling volumes of those customers. For example, AT&T's total customer service expenditures for 1993 were $6.6 billion. From 1989 through 1993, the aggregate growth in AT&T's operating revenues net of access charges was only 13 percent, while customer-service expenses increased by 28 percent. Account-specific variable customer acquisition and retention expenses (*e.g.*, for direct marketing, billing, customer service) could add from $0.02 to $0.03 to incremental costs per overall conversation minute, and may add significantly more or less in the case of an individual

---

total AT&T conversation minutes of 170.4 billion in 1993. (The estimate of conversation minutes was provided by AT&T.).

[36] The comments made herein can also be addressed to the claim by Richard Schmalensee of low incremental costs (and high price-cost margins). See *Affidavit* of Richard L. Schmalensee, note 9, *supra*, page 8.

service.[37] An appropriate estimate should take account of differences in customer monthly billing habits and customer churn (which determines the expected customer life over which costs should be amortized).

As we noted earlier, it is not surprising that sales and marketing expenses have grown as long-distance markets have become more competitive. Increased competition generates increased customer churn, as customers seeking the best deal switch carriers with greater frequency. A comparison of changes in customer access lines by carrier would underestimate the fluctuations in market shares because many of the changes are offsetting (*i.e.*, while some customers switch from AT&T to MCI or Sprint, others switch to AT&T). Hence, aggregate market share data may mask important shifts by customers at the margin. The increased churn is a direct result of intensifying competition among the long-distance carriers. As each of the carriers respond with new promotions, improved service quality, and enhanced features, telemarketing and customer service expenditures increase. As network costs have fallen, in part because of the intense effort to expand capacity in recent years, these customer-specific, production-sensitive costs are becoming more important, and should not be ignored in a calculation of incremental costs.[38] By neglecting these costs, MacAvoy underestimates incremental costs significantly, and ignores additional evidence of the level of intense competition in long-distance markets.

---

[37] This estimate is based on 1993 Customer Service expenditures of $6.6 billion, as reported in AT&T's Form M (line 700) using the same methodology described in footnote 35 above discussing the estimation of incremental network maintenance expenses.

[38] Plant-specific network operating costs have fallen from $3.5 billion in 1988 to $2.5 billion in 1993, while customer operations expenses have risen from $5.0 billion to $6.6 billion over the same period (see AT&T's 1993 Form M report).

Another important incremental cost which should be considered is the allowance for uncollectible bills, which has been rising in recent years for AT&T (also not surprising given the intensifying of competition). In 1993, AT&T's allowance for uncollectible revenues amounted to 3.1 percent of total revenues, adding a corresponding $0.005 per average conversation minute to total incremental costs. This estimate is conservative because conversation minutes which are billed but which are not paid for nonetheless incur direct operating costs. Because of the increased customer churn, it is not surprising that allowances for uncollectible bills have been increasing in recent years. The estimated cost for uncollectible bills is likely to vary significantly depending on the customer and service type, and is likely to differ by carrier.

Combining these adjustments suggests that incremental costs (before access charges) are more likely to be in the range of $0.035 to $0.063 per conversation minute, instead of the $0.01 per minute assumed by MacAvoy.[39] As we noted above, these adjustments are only approximate and, indeed, may understate the costs of providing specific services. We provide these estimates only to demonstrate the extent to which MacAvoy's approach to estimating trends in price-cost margins biases his results in favor of finding rising margins.

This upward bias is likely to be sufficient to refute the pattern of rising margins suggested by MacAvoy. According to MacAvoy:

> These findings are not sensitive to the estimates of marginal cost employed in this analysis. In order for the trend in price-cost margins to be reversed, marginal costs

[39] The lower bound is estimated as $0.01 (incremental network costs) + $0.02 (incremental sales and marketing costs) + $0.005 (uncollectible costs) = $0.035. The upper bound is estimated as $0.028 (incremental network costs associated with capital and maintenance) + $0.03 (incremental sales and marketing costs) + $0.005 (uncollectible costs) = $0.063.

> would need to be increased by more than 57 percent in 1990 and by more than 75 percent in 1993, relative to the marginal costs in 1985. Recall that marginal costs include access charges and operating costs. Since there is little disparity in the access charges reported by the FCC and WEFA, for the trend in price-cost margins to be reversed, marginal operating costs would need to be increased by a factor of four in 1990 and a factor of five in 1993, relative to 1985, to change the direction of the relationship between concentration and price-cost margins. (page 41)

The adjustments suggested above are conservative and clearly demonstrate that a fourfold or fivefold upward correction to MacAvoy's operating cost estimates (exclusive of access charges) is reasonable.

B. MacAvoy's Model of Competition and the Role of Fixed Costs

In his review of models of imperfect competition, MacAvoy focuses his discussion on models based on conjectural variation (in particular, those of Cournot and Bertrand)[40] and tacit collusion.[41] In each case, it is difficult to apply the representations offered by MacAvoy to the long-distance telecommunications industry.

There are two significant problems with the application of the Cournot and Bertrand approaches to the long-distance telephone services industry. First, the models are "static;" that is, they describe outcomes when transactions take place once in a market. They are not consistent with dynamic competition over many periods. Second, the numerical illustration offered by MacAvoy (p. 34) corresponds to an industry in which firms have no fixed cost. It

---

[40] See A. Cournot, *Recherches sur les Principes Mathematiques de la Theorie de Richess* (1838); and J. Bertrand. "Theorie Mathematique de la Richesses Sociale," *Journal des Savants* (1883).

[41] See, *e.g.*, the discussion of Dennis W. Carlton and Jeffrey M. Perloff, *Modern Industrial Organization*, 2nd ed., New York: Harper Collins. Publishers, 1994.

is clear that the provision of long-distance services involves significant fixed costs which must be recoverable in a stable dynamic equilibrium.[42] The firms in his model have no headquarters, no sales and marketing expenses, and no existing network to support. Indeed, firms pricing as his stylized model proposes resemble stripped down resellers more than major long-distance carriers.

Even if one followed MacAvoy's example of Bertrand competition, only one firm would survive if price fell below average cost (and marginal cost is likely to be below average cost). Under Cournot competition the number of firms would be greater than one, but the constraint that fixed cost be recovered would still be present in a proper presentation. Because MacAvoy makes no attempt to estimate the magnitude of such costs, it is difficult to apply the Cournot and Bertrand approaches he suggests.

C. *Revision of MacAvoy's Estimated Price-Cost Margin Trends*

In the preceding sections we have identified problems with MacAvoy's approach to estimating prices and costs. It is not necessary, however, to include estimates for the variable (and fixed) costs omitted by MacAvoy in order to reject MacAvoy's conclusion regarding the trend in price-cost margins. Since MacAvoy assumes non-access costs are constant, it is sufficient to show that average long distance prices, net of access costs, have declined from 1990 until 1993. This is indeed the case, as demonstrated earlier in Figure 3.

---

[42] Accurately estimating a long-distance carrier's long-run average costs is extremely difficult, but the magnitude of MacAvoy's omission is suggested considering corporate overhead. In 1992, AT&T's general and administrative expenses were $5.3 billion, which translates into an average cost per minute of $0.029.

We are unable to reproduce MacAvoy's analysis of Herfindahl-Hirschman indices of concentration because the background materials for these estimates were not provided as requested. However, it is not necessary to determine whether concentration increases, decreases, or remains constant. MacAvoy's conclusions are based on the alleged relationships he determines between concentration and price-cost margins. A declining trend in average prices net of access charges refutes the basic premise of implicit tacit collusion.

D. MacAvoy's Empirical Analysis of Tacit Collusion

In his review of market conditions facilitating tacit collusion, MacAvoy (page 29) emphasizes few firms, stable market shares, homogeneous services, firms with similar cost levels, and barriers to entry. None of these conditions is satisfied in the long-distance telephone industry. First, there are several long-distance carriers serving each interstate long-distance market. As of June 1993, nine carriers served 45 or more states (up from four in 1988), five carriers served 25 to 44 states (as in 1988), 19 carriers served 12 to 24 states (up from three in 1988), 85 carriers served four to 11 states (up from 21 in 1988), and 118 carriers served four or more states (up from 33 in 1988).[43] Second, as we noted earlier market shares change significantly over the course of a year, and customer churn is important. Third, the rapid pace of introduction of discounting and promotional programs makes it difficult to standardize a product. Fourth, there are good reasons to believe that AT&T's operating costs are higher than

---

[43] See Federal Communications Commission, *Long Distance Carriers and Their Code Assignments, Second Quarter 1994,* Washington, D.C.: Industry Analysis Division, September 1994.

The most recent merger of LDDS and ATC, and their subsequent acquisition of Metromedia, reduced the number of nationwide carriers from nine to seven.

those of MCI and Sprint. These include the fact that AT&T has a unionized labor force, while Sprint and MCI do not and the fact that AT&T has a larger share of customers who bill small amounts per month (and hence are more expensive to service on a conversation-minute basis). Finally, as we argued earlier, there are no significant barriers to local or national entry.

The econometric model used by MacAvoy can be derived as follows.[44] In a market with undifferentiated products, it is possible to relate the price-cost margin to industry structural conditions. For a given industry segment, a firm's price-cost margin (*PCM*) can be expressed as:[45]

$$PCM_i = \frac{P - MC_i}{P} = \frac{s_i(1 + v_i)}{\varepsilon}, \qquad \text{Equation (1)}$$

where P and MC represent, respectively, price and marginal cost; s_i is the ith firm's market share, v_i is its "conjectural variation" (the ith firm's guess about the output response of all other firms), and ϵ is the industry demand elasticity. Reference points of interest for the firm are the monopoly outcome, $PCM = 1/\epsilon$, and the Cournot outcome, $PCM = s_i/\epsilon$.

Industry (or, in the case of MacAvoy's analysis, industry-segment) expressions can be derived by aggregating equation (1) across firms (as long as marginal cost equals average variable cost, which we know is not the case for telecommunications services):

---

[44] We were unable to reproduce nor fully examine MacAvoy's results since the supporting data and detailed estimation results were not provided as requested. Without the detailed econometric results it is impossible to determine whether MacAvoy adequately controlled for such things as time effects.

[45] See, *e.g.*, the discussion in Michael Waterson, *Economic Theory of the Industry*. Cambridge: Cambridge University Press, 1984; and Ian Domowitz, R. Glenn Hubbard, and Bruce C. Petersen, "Oligopoly Supergames: Some Empirical Evidence on Prices and Margins," *Journal of Industrial Economics* 35 (June 1987): 379-398.

$$Industry\text{-}segment\ PCM = \frac{H}{\varepsilon}(1 + \mu),$$

where μ is defined as a weighted sum of conjectural variation terms ($\Sigma s_i^2 v_i / \Sigma s_i^2$), and H = Σs_i^2 is the Herfindahl-Hirschman index of market concentration. MacAvoy's model is derived under the assumption of Cournot behavior, so that the firms' conjectural variations are all zero, μ = 0, and:

$$Industry\text{-}segment\ PCM = \frac{H}{\varepsilon}.$$

In his empirical tests, MacAvoy estimates a model of the form:

$$PCM_{it} = \alpha_i + \beta(H_{it} / \varepsilon), \qquad \text{Equation (2)}$$

where α_i represents different intercepts for each industry segment (switched outbound; dedicated outbound; dedicated outbound, 36 months; switched inbound, dedicated inbound; and virtual network), and β is a coefficient to be estimated. His principal findings from estimating equation (2) are two. First, the estimated β's over the 1987-1990 and 1991-1993 periods are negative, rejecting the Cournot assumptions. Second, the estimated β is statistically and economically more significantly negative in the second period, suggesting that *decreases* in concentration (measured by a fall in the Herfindahl-Hirschman index) are associated with *higher* price-cost margins, a finding he interprets as evidence in favor of tacit collusion in pricing among AT&T, MCI, and Sprint.

MacAvoy's conclusions cannot be justified based on his analysis for two reasons. First, the model he uses cannot accept or reject tacit collusion. Second, as we noted earlier, his measures of "price" and "cost" used to construct price-cost margins are so flawed as to render

meaningless any analysis of the determinants of margins.

Models of tacit collusion attempt to express implicit mechanisms through which rivals can achieve price-cost margins near cooperative (*i.e.*, monopoly) levels. In such mechanisms, rivals must be able to discipline "cheating" (*i.e.*, secret price cutting to steal customers). George Stigler's[46] classic work on detection showed that the smaller the number of sellers, the fewer new buyers, and the higher the probability of repeat purchase, the more likely that cheating will be detected. However, in the case of long-distance telephone service, customer switching costs are low, as evidenced by the significant customer churn. Moreover, prices are difficult to compare in the aggregate (because a firm would need to know its competitors' traffic mix to determine whether they were "cheating"), but easy to compare for an individual consumer for whom calling patterns are private information. Hence, the heterogeneity of pricing plans works against the viability of tacit collusion among long-distance carriers.

Even if one accepts MacAvoy's construction of "price" and "cost," the panel data results are difficult to interpret. The absence of year effects, which are conventionally included in such models, in this case *forces* the negative trend correlation between *PCM* and *H* to be accounted for in the estimated value of β. However, as we noted earlier, there are many reasons to doubt

---

[46] George J. Stigler, "A Theory of Oligopoly." *Journal of Political Economy* 72 (January-February 1964): 44-61.

A more contemporary literature on repeated noncooperative games ("oligopoly supergames") suggests that, under certain conditions, price-cost margins may be sustained at high levels in the interval between the Cournot and monopoly outcomes. There is little evidence to support the occurrence of such successful arrangements in contemporary U.S. industry. In their analysis of U.S. manufacturing industries, Domowitz, Hubbard, and Petersen conclude that "the levels of price-cost margins of concentrated, producer-goods industries, while higher than those of unconcentrated counterparts, appear to be closer to those predicted by a single-period Cournot-Nash equilibrium than monopoly." See Ian Domowitz, R. Glenn Hubbard, and Bruce C. Petersen, note 45, *supra*, page 396.

the trend in price-cost margins suggested by MacAvoy. We have demonstrated that prices net of access charges are falling over the period studied by MacAvoy; moreover, many other incremental costs appear to be stable or rising over the period.[47] Hence, there is no reason to expect that a negative estimated value of β would prevail.

E. Using Financial Data to Analyze Price-Cost Margins

As we noted earlier, it is difficult to measure the marginal "price" precisely given the presence of complex and nonlinear tariffs for long-distance telephone service. Moreover, alternative definitions of "marginal cost" are possible. Consequently, there exists no single perfect measure of the ratio of price less marginal cost to price. It is concerns such as these that cast doubt generally on the usefulness of statistical tests such as those presented by MacAvoy.

Because of inherent difficulties in measuring "profitability," no single measure permits definitive conclusions. Accordingly, we consider additional approaches beyond those put forth be MacAvoy. One approach used by financial economists is to assume that financial market valuation of firms' assets captures as accurately as possible the present value of profit opportunities.[48] The pioneering technique, introduced by Nobel Laureate James Tobin,[49] focuses on a summary statistic known as q, the ratio of the market value of the firm to the

---

[47] For example, sales and marketing expenditures as a share of total revenue have been increasing and customer churn has increased in recent years, which causes the margin per conversation minute to decrease.

[48] We noted earlier that measures of return on assets for AT&T, MCI, and Sprint did not indicate abnormal profits.

[49] See James Tobin, "A General Equilibrium Approach to Monetary Theory," *Journal of Money, Credit, and Banking* 1 (February 1969): 15-29; and James Tobin and William Brainard, "Pitfalls in Financial Model Building," *American Economic Review* 58 (May 1968): 99-122.

replacement cost of the firm's capital stock. Tobin's insight is that, all else equal, a rise in a firm's q gives the managers the signal to increase the firm's investment, while a fall in a firm's q gives the managers the signal to decrease the firm's investment. In a competitive market, under certain conditions, a firm's q should equal unity in the long run, indicating that the firm's capital stock is at its most efficient level. Adaptations of the q approach have been used successfully to study firms' investment decisions.[50]

The intuition that firms' q values should be around unity in equilibrium does not hold in the presence of monopoly power.[51] In that case, the q of the firm with market power exceeds unity, reflecting the capitalized value of monopoly rents. If, however, there were no significant barriers to entry, competing firms could enter, expanding capacity and reducing prices, pushing q values for firms in the industry back toward unity.

Following research by Eric Lindenberg and Stephen Ross,[52] one can formalize this way of inferring potential noncompetitive pricing from data on firms' q values. Specifically, under the assumptions of constant elasticity of demand and positive (gross) investment,

$$q \geq 1 + \left(\frac{P - AC}{P}\right),$$

where P represents "price" and AC represents "long-run average costs." That is, q exceeds

---

[50] See, *e.g.*, the analysis and review of existing studies in Jason G. Cummins, Kevin A. Hassett, and R. Glenn Hubbard, "A Reconsideration of Investment Behavior Using Tax Reforms as Natural Experiments," *Brookings Papers on Economic Activity* (1994: 2): 181-249.

[51] Even a competitive firm can, in principle, have a q value in excess of unity if it is lowest-cost producer in an industry.

[52] Eric B. Lindenberg and Stephen A. Ross, "Tobin's q Ratio and Industrial Organization," *Journal of Business* 54 (January 1981): 1-32.

unity by the markup of price over long-run average cost.[53]

Using the approach outlined in an empirical study by Jason Cummins, Kevin A. Hassett, and R. Glenn Hubbard,[54] we calculate the q ratios for AT&T, MCI, and Sprint over the period from 1987 through 1992 examined by MacAvoy[55] Over the full period, the constructed average annual q ratios ranged from 0.46 for AT&T to 1.1 for Sprint to 2.05 for MCI. By comparison, the median q ratio for the U.S. firms studies by Cummins, Hassett, and Hubbard averaged 1.74 over the period. Accordingly, the q ratios for AT&T and Sprint offer no support for exploitable market power. (The higher q value for MCI is explained in part by a high q ratio in 1989.)

---

[53] As we noted earlier, a key problem with the static Cournot analysis in MacAvoy's study is that it ignores the importance of fixed costs, which are obviously significant in the provision of long-distance telephone service. This omission becomes still less realistic when one considers two other features of investment decisions stressed in contemporary economic analysis, *irreversibility* and *uncertainty*. The former refers to the fact that capital investments are often sunk costs. The latter refers to the fact that the prices of services, the marginal cost of providing those services, and even the cost of capital investments are, in principle, unknown and subject to fluctuation. The interaction of irreversible investment and uncertainty implies that price can depart from long-run average cost (or equivalently, firms' q values can depart from unity) for a significant period of time even in a competitive industry. Consider, for example, the case of a competitive industry, in which potential entrants can compete by undertaking a single irreversible investment, requiring an initial sunk cost. Suppose, further, that all uncertainty reflects unknown fluctuations in future demand. In the competitive equilibrium under uncertainty, the threshold price triggering entry exceeds long-run average cost by an amount increasing in the rate at which trend industry demand is expanding and in the variability of shocks to industry demand. This implies that the q values of incumbent firms exceed unity as well, even in the absence of monopoly power. For reviews of models and empirical analysis, see Avinash K. Dixit and Robert S. Pindyck, *Investment Under Uncertainty*, Princeton: Princeton University Press, 1994; and R. Glenn Hubbard, "Investment Under Uncertainty: Keeping One's Options Open," *Journal of Economic Literature* 32 (December 1994): 1794-1807.

[54] See Jason G. Cummins, Kevin A. Hassett, and R. Glenn Hubbard, note 50, *supra*.

[55] We were not able to construct q for 1993 owing to data limitations.

In his analysis of financial data, MacAvoy emphasizes evidence from stock price reactions to announced rate changes by AT&T as corroborating his hypothesis of tacit collusion among AT&T, MCI, and Sprint. Specifically, he argues that announced price increases by AT&T should have no effect on the stock market valuation of MCI and Sprint if the markets for long-distance telephone services were competitive. He finds that announced rate increases by AT&T (on October 23, 1990, July 20, 1993, September 17, 1993, December 29, 1993, and January 25, 1994) cause an average increase of 3.4 percent in the stock prices of MCI and Sprint (net of any general movements in the stock market). There are many problems with inferring significant noncompetitive behavior from this "event study."

The event study methodology employed by MacAvoy requires that "events" be exogenous and unanticipated developments that change investors' valuation of a firm or firms' profit opportunities.[56] In the cases considered by MacAvoy, the underlying experiment is ill-defined. If AT&T had market power, why did it choose to exercise it only on certain dates, and surprise investors with its newfound wisdom?

In a separate attachment to his affidavit,[57] MacAvoy described his criteria for selecting events:

> Six recent major AT&T rate increase announcements were identified through a literature search. A rate increase announcement was included in the sample if it was reported in either the *Wall Street Journal* or the *New York Times*, and the announcement date was designated as the date of the announcement's first appearance in one of the two

---

[56] Technical problems in interpreting simple event studies are reviewed in B. Espen Eckbo, Vojislav Maksimovic, and Joseph Williams, "Consistent Estimation of Cross-Sectional Models in Event Studies," *Review of Financial Studies* 3 (1990): 343-365.

[57] Paul W. MacAvoy, "Analysis of AT&T Rate Increase Announcements," Supplement to *Affidavit*.

newspapers. (page 2)

MacAvoy finds six such events; one, on November 20, 1993, "was deleted from the sample because of a major telecommunications court decision immediately after the rate announcement" (page 5).[58] Hence, he analyzes responses of excess returns on portfolios of MCI and Sprint or of AT&T, MCI, and Sprint to the news in the five "key events."

Using MacAvoy's criteria, we found thirteen events of AT&T rate increases over the period from July 1990 through January 1994, including the six chosen by MacAvoy. The announcement dates were July 17, 1990, October 23, 1990, January 22, 1991, May 19, 1992, August 7, 1992, December 10, 1992, February 10, 1993, June 7, 1993, July 20, 1993, September 17, 1993, November 22, 1993, December 29, 1993, and January 25, 1994. Based on the supplement to MacAvoy's affidavit, we were unable to determine on the basis of what criteria MacAvoy excluded seven of the thirteen events appearing in *The Wall Street Journal* or *The New York Times*.

There is good reason to believe that at least some the events selected by MacAvoy conveyed information to financial markets other than that suggested by MacAvoy.[59] For example, the October 23, 1990 event follows by a week a major announcement by MCI (following one by Sprint) of a new Personal 800 service; still more significantly, it precedes by

---

[58] In fact, the event was actually reported on November 22, 1993.

[59] The estimated increases in stock market value for MCI and Sprint are large given the actual changes in revenues. Underlying Table 4 of the *Affidavit*, MacAvoy finds three-day cumulative abnormal returns for MCI and Sprint of between 3 and 3.59 percent. In a literature search for the events, we found no evidence that AT&T price increases were projected to increase total current revenue by this much. Hence, even if incremental revenue were generated at no cost and long-distance prices stayed constant (in contrast to the trend of price declines), the stock market reaction appears large.

a day a federal court decision to remand to the FCC a decision about how AT&T would be permitted to offer competitive discounts to large business customers. Favorable share price responses for MCI and Sprint would be predicted in these cases.

The July 20, 1993 event follows an announcement (on July 19) that California regulators were expected to open the way for long-distance companies to compete against local-exchange carriers in California, an announcement by AT&T (on July 14) that it will use a new patented technology to enhance the sound quality of calls made over its network, and an announcement by Sprint (on July 12) of a new international discount calling plan; on July 21, Sprint reported unexpectedly large earnings growth.

The September 17, 1993 event follows an announcement by Sprint (on September 16) of lower rates on its discount calling plan "The Most." On September 16, AT&T signed an agreement with Datapoint to develop the automatic call distribution in Europe; on September 17, California regulators finally decided to permit long-distance carriers to compete in local-exchange markets. MacAvoy's event also falls within the event window studies by Kenneth Lehn[60] in the context of the FCC's decision to allocate spectrum for PCS licenses. This event may have changed investors' valuation of MCI's and Sprint's wireless operations.

The November 20, 1993 event (which we date as November 22) follows an announcement by AT&T (on November 16) of a new program in which customers receive frequent-flier miles for dollars spent on long-distance service. The December 29, 1993 event preceded closely a January 2, 1994 announcement by MCI of a major investment in a fiber-optic

---

[60] See *Affidavit* of Kenneth Lehn, Motion of Bell Atlantic Corp., BellSouth Corp., NYNEX Corp., and Southwestern Bell Corp. to Vacate the Decree, *United States of America v. Western Electric Company and American Telephone and Telegraph Company*, Civ. No. 82-0192.

local network; on December 31, S&P provided a bullish announcement about the credit quality of AT&T's debt. In addition, according to the account of MacAvoy's event in *The New York Times* (December 29, 1993, page A3), AT&T indicated that increased revenue from higher basic telephone rates would be offset by lost revenue from existing savings plans. It is, therefore, curious that MacAvoy estimates a stock price reaction for this event similar to those he estimates for other events, in which profits were expected to rise.

On January 25, 1994, one of MacAvoy's event dates, MCI announced a major telecommunications joint venture in Mexico. On that same date, Sprint, GTE, and BellSouth announced the undertaking of a $160 million project to transmit voice, data, and video images. Hence, there are reasons to believe that the effects on stock returns of the "events" presented by MacAvoy may capture other influences.

In addition, one cannot infer information about the potential for noncompetitive pricing without accounting for differences in long-run average costs. From the perspective of the q framework analyzed earlier, a stock market change in response to a rate announcement reflects the capitalized value of the change in price relative to long-run average cost. The market, for example, may react positively to an action taken to cover a previous increase in cost. In addition, if MCI and Sprint had lower long-run average costs than AT&T, their stock price could rise in response to AT&T's rate increase announcements even if the industry were competitive. Absent an analysis of variation in long-run average cost across firms, one cannot use the results of MacAvoy's event study as *prima facie* evidence of noncompetitive pricing.

To summarize, the event study evidence offered by MacAvoy cannot be interpreted as supporting noncompetitive pricing behavior.