The Cost of Competition in the Telephone Industry

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1. Introduction

Comprehensive regulation of the telephone industry began in 1907. Much of the debate over the need for regulation focused on the issue of whether competition or a regulated monopoly provided greater benefits to consumers.

Until 1894, when Alexander Graham Bell's telephone patents expired, the American Telephone and Telegraph Company (AT&T) had had exclusive control of the market. The period between 1894 and 1907 was marked by intense and extensive competition between the incumbent, and its rivals, known collectively as the Independents. Out of 1,051 U.S. cities with a 1902 population greater than 4,000, 1,002 had telephone facilities. Forty-one percent of these 1002 cities were served exclusively by Bell, fourteen percent were served exclusively by the Independents, and forty-five percent were served by two firms--AT&T and an Independent [United States 1906, p.26]. From 1895 to 1905 the rivalry contributed to a decline in AT&T's revenue per telephone for local service from $70 to $33.[1] The price decline, and the initiation of service to smaller towns and cities that had not been developed by AT&T, led to an annual rate-of-growth of over twenty percent in the number of telephones-in-service per capita [United States 1975, 2:783].

Despite these gains, Richard Ely and others notable economists argued that competition should be replaced by regulation. Even though competition had stimulated the market, the proponents of regulation believed that a regulated monopoly was the optimal market structure. They argued that because of the public good nature of the product, only one firm should provide local telephone service. The competitive firms did not interconnect, and therefore if customers wanted to have access to all customers, they had to rent

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[1]During the same period, toll revenue per telephone declined from $11 to $10. American Telephone and Telegraph's 1909 Annual Report, reprinted in Commercial and Financial Chronicle 90 (March 19, 1910), p.784. Between 1894 and 1906 the consumer price index rose four percent. [United States 1975, 1: 211].

the incumbent. Section 2 provides an overview of the industry and an analysis of the investment strategy followed by the incumbent firm. Section 3 describes the model, data and variables used in the analysis. Section 4 reports the empirical results. They suggest that the cost of duplicative structural investment was not large, and that the larger costs associated with rivalry were due to AT&T's strategy of building excess capacity into its network at competitive points.

2. The Wisconsin Telephone Industry: An Overview

This study will focus on the cost structure of the telephone industry in Wisconsin That market is of special historical interest because, in granting oversight powers to the Wisconsin Railroad Commission, it was the first state to establish comprehensive regulation of the industry, and the law served as a regulatory model for other areas of the country [Lyerla 1936, pp. 48-50, 66; Blackford 1970, p.314].

During the competitive era, Wisconsin Telephone was the largest telephone company in the state, providing service in 73 cities. As of 1910, the Bell Operating Company faced a rival in 13 markets, and had acquired former competitors in 12 other cities.

Entrants had been attracted to the industry because of wide-spread consumer dissatisfaction with the price and quality-of-service, and the failure of the incumbent to develop the market in small cities and towns.[4] Furthermore, the industry appeared to be quite profitable. During the patent era, AT&T earned an average return of 46% on its investment around the nation, while the nominal cost of money was approximately five cent [Bornholz and Evans 1983, p.25].

Entry into the industry quickly dissipated these monopoly profits. For example, at the end of the patent period, Wisconsin Telephone was earning a

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[4] Wisconsin State Journal, December 31, 1895 and March 2, 1896.

proponent of regulation. In its presentation to the State assembly, as well as in advertisements placed in the media, the firm emphasized that there was a large waste of resources associated with duplicative telephone facilities.[9] No evidence was provided to support this position. In the next section of the paper, I review the available engineering economics data on the cost of competitive telephone systems.

Engineering Studies

During the debates on the merits of competition versus regulation, there was little dispute about the demand-side impact of competition. About fifteen percent of the customers obtained service from both suppliers.[10]

Little evidence was available to legislators regarding the cost of a competing system. Albert Allen, an engineer whose work was endorsed by AT&T, concluded that, at competitive points, the percentage of wasteful, duplicative investment was approximately sixty-nine percent. Gansey Johnston, one of the leading spokesmen of the national Independent movement, argued that competition raised per-customer-investment by approximately seventeen percent. Based on his engineering study, Johnson concluded that "[t]he duplication which appeals to the imagination is more apparent than real, and so far as it is real it is in the less costly portions of the plant."[11]

Allen's and Johnston's estimates were based on engineering economic estimates. In the course of two merger cases, the Staff of the Wisconsin

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[9]Wisconsin Telephone Company, "Telephone Talks," no.13, 1906, Wisconsin State Historical Society; Milwaukee Journal, July 27, 1906; "Regulation of Public Utilities: Hearing and Comments on Wisconsin Legislative Bills No. 581S and 933A, 1907," Wisconsin Legislative Reference Bureau.

[10]Harry P. Nichols, "Result of Investigation of the Operation of a Dual System of Telephones in Various Cities," November 21, 1906, p. 13, ATTCA.

[11]Bell Telephone News 1 (May 1912); and Telephony, 16 (November 7 and December 12, 1908), pp. 460 (quote), and 610.

The variation in the findings appear to be attributable to two factors. First, in Janesville, Wisconsin Telephone purchased additional classes of property, general equipment, central office equipment, and telephones, that due to technological obsolescence or duplication, were of little or no economic value. Furthermore, the staff concluded that the underground facilities of the Janesville Independent would be of no use to Bell, while they believed that all of Bell's La Crosse underground facilities could be used by the Independent.[15]

The varying economic value of the outside plant at the two cities is likely attributable to the suppliers' investment strategies. Wisconsin Telephone built its exchange plant, according to its general manager and vice-president W.R. McGovern, "with the idea of handling the entire business..." In anticipation of controlling the entire market, Bell's spare capacity at competitive points ranged anywhere from fifty percent upward. The Independents, on the other hand, did not make such a large allowance for future demand. At both Janesville and La Crosse, the Independents operated at almost full capacity. Therefore, when La Crosse Telephone acquired Bell's facilities, the Independent was able to use much of its former rival's facilities. Due to Wisconsin Telephone's decision to construct facilities in anticipation of capturing the entire market, little of the Independent's facilities at Janesville were of useful value.[16]

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[15]Janesville Memorandum, p. 2-3; La Crosse Memorandum, p. 7, 17.

[16]W.R. McGovern to George C. Mathews (quote), March 29, 1921, in case file U-2351, In Re Janesville Purchase Case: Wisconsin Telephone Company and Rock County Telephone Company, WSHS; and testimony of W.F. Goodrich, In the Matter of the Application of the La Crosse Telephone Company for Authority to Increase Its Rates, Tolls, and Charges, case U-1503, February 7, 1919, p. 21-22, WSHS.

The construction of excess capacity also occurred outside of Wisconsin. For example, in 1902 AT&T's competitive exchange in St. Louis was renting out only 52% of its installed lines. Pickernell/Thayer, June 2, 1909, box 4, "Bell Telephone Company of Missouri," ATTCA.

engaging in prolonged warfare in competitive markets, Bell sent a signal to potential entrants in other cities that entry would entail a financial loss [Selten 1978, p.127]. According to a director of a Bell Operating Company that faced strong competition in Ohio, Indiana and Illinois, his firm responded aggressively to entry "as a warning to other investors" who were considering entering the incumbent's monopoly markets.[18] If this signal was effective, the earnings in monopoly markets may have more than compensated Bell for its losses at competitive points. The Independent firms did not need to signal potential entrants in other markets since they typically served only one city.

Caves and Porter have argued that following entry, an incumbent may make strategic investments that act as mobility barriers [1977]. The going concern's excess capacity may serve as a signal that deters the newcomer from expanding or entering new markets. The impact of Bell's investment strategy is reflected in the correspondence of the Independents. The entrants were disheartened by Bell's construction at competitive points and this may have raised the probability that they would sell their properties to Bell.[19]

3. Empirical Test of the Cost Structure of the Telephone Industry

The available engineering studies suggest that competition affected the cost of supplying telephone service through the duplication of structural investment, and because of AT&T's decision to respond aggressively to competition at competitive points. In this section of the paper I will provide the results from an econometric estimate of the impact that market structure had on the level of investments, as well as the annual cost of

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[18]L.N. Whitney, "Report on Conditions in Indiana," August 1907, p.5, box 11, Museum of Independent Telephony.

[19]Harper/Salmon, May 4, 1900 and Clarke/Harper, June 2, 1900, Dane County Telephone Company Papers, Wisconsin State Historical Society.

similar population, and then setting uniform rates for all cities in a particular grouping. Rates were not based on city specific cost estimates.[21]

The capital level was influenced by two important network variables, the size of the territory served and the number of buildings housing switchboards. In order to serve a market, poles and conduit served as supporting structures for the wires that went between the customers and the switchboard. A market included both urban and rural territory. Approximately six percent of Wisconsin Telephone's customers lived in rural areas. Consequently the territory served by a telephone company is traditionally measured by the miles of pole lines (MOPL) and underground conduit (MOC) [Wright and Judd 1923, pp. 8,25], rather than the square mileage of a city.[22] The coefficients on the variables MOC, MOPL, MOC^2 and $MOPL^2$ measure the cost of the structural investment required to serve a territory, independent of the number of customers served.

Of the 67 exchanges included in the sample,[23] only two cities had more than one central office. Multiple-office exchanges were constructed when there was a sufficient number of customers outside of the central business district who wanted telephone service. The construction of multiple offices allowed the telephone company to shorten the length of the wires to customers in outlying areas. On the other hand, where subscribers were served out of multiple-offices, additional operator expenses were incurred. For calls between offices, an "A" operator connected the customer originating the call, to a "B" operator in the terminating office. For calls that originated and

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[21]Minutes of the Board of Directors, Wisconsin Telephone Company, March 5 and April (n.d.) 1895, ATTCA; and French/Burt July 24, 1902 and Sherwin/French July 18, 1902, General Manager Letter Books, v.639 ATTCA.

[22]Furthermore this measurement of market size is superior to the square mileage of a city because it controls for property inside the market boundaries, but not connected to the telephone network (e.g. park land).

[23]Six cities were excluded from the regression because of insufficient data.

The data for the regression analysis was obtained from the year ending June 30, 1910 annual report of the Wisconsin Telephone Company. Since data was filed on an exchange basis, the annual report provides a rich source of cross-sectional data.[25]

Prior to 1911, the Wisconsin statutes did not require an entrant to obtain an entry certificate from the regulatory commission. Therefore the data set reflects conditions when entry was not prohibited by state statute. Furthermore, the municipalities power to limit entry through the granting of a franchise was limited. The State Supreme Court had held that the cities were only authorized to pass ordinances that prevented obstructions to the cities' streets and provided safety protection to its citizens.[26]

I did not use cost data for the Independent firms because, by restricting the data set to one company, the collection of the cross-sectional data should be free of measurement errors. Due to the absence of accounting standards, if different companies were included in the sample, biased coefficients might have been obtained due to errors of measurement. Costs that were capitalized by some firms were expensed by others.[27]

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[25]Much of the data is neatly summarized in Wisconsin Railroad Commission Annual Reports, 5 (1911), pp. 483-89, 684-703, 766-69. Additional information was obtained from the annual report of the Company, as filed. Annual Reports of Telephone Companies, WSHS, series 1337, files 900-985.

During this era, plant used in common by local and toll services were recorded on the books as exclusively exchange investment. Facilities used exclusively for toll service are not included in the data set. Therefore, the data has not been subject to any arbitrary, cost allocations (separations). Ibid., Annual Report of Wisconsin Telephone Company: Toll Operations, year ending June 30, 1909. See Temin and Peters for a discussion of the separations process [1985].

[26]Wisconsin Telephone v. City of Milwaukee, 126 Wisconsin Reports 1, 7-12 (1905); and 1911 Wisconsin Assembly Journal, Bill 886A.

[27]L.H. Howe et. al. v. Footville Telephone Company, Wisconsin Railroad Commission U-811 (1915), Transcript pp. 2-7, Footville Historical Society, Footville, Wisconsin.

INDPHONE suggests that for each customer served by an independent, Wisconsin Telephone's capital stock increased by $26.85. The coefficient on variable INDPHONE suggests that Wisconsin Telephone not only over-built its exchange at La Crosse, but acted similarly at other competitive markets.

The coefficient on MOC, MOPL and MOC^2 are statistically different than zero at the five percent level of significant, while the coefficient of MOPL and $MOPL^2$ is not. The insignificant t-statistic is likely due to the high multicolinearity between the independent variables. Since b(9) is an unbiased estimates of $\beta(9)$, I will use it, along with b(6), b(7) and b(8), to compare the cost of duplicative, fixed, structural investment, with the incumbent's costs incurred due to over-building.

With the exception of the level of excess capacity, the Independents' construction methods were similar to Bell's. In Wisconsin, the rivals used the same technology: copper wires, manual switchboards, and telephones equipped with long-distance transmitters. The equipment supply market was competitive, and the prices paid by Wisconsin Telephone to AT&T's manufacturing subsidiary, Western Electric, were comparable to the charges of the Independent suppliers.[31] Therefore, the cost of the Independents duplicative structural investment can be estimated by multiplying the number of Wisconsin Telephone conduit and pole miles at competitive points, by the coefficients b(6), b(7), b(8), and b(9). In Table IV I compare this structural investment with the predicated costs incurred by Wisconsin Telephone because of the construction of mobility barriers. The dollar value of the excess investment is estimated by multiplying b(4) by the number of

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[31]J.C. Harper to William J. Bell, January 25, 1900, Bell to Harper, April 14, 1900, W. H. Buck to Harper, February 24, 1900, C.B. Salmon to William J. Latta, April 4, 1900, Dane County Telephone Papers, WSHS; Stehamn 1925, p.95; and "Opinion Rendered by Judge William Dever," January 20, 1917, slip. op. pp. 90-95, Read et. al. v. Central Union Telephone Company, Superior Court of Cook County Illinois, Chancery General Number 299,689, ATTCA.

are reported on Table V.[34]

In model two, the parameter estimates for the number of subscribers served by the Independents, conduit and pole line miles are statistically significant at the five percent level of significance. The coefficient for $MOPL^2$ is not. Again, this is likely due to the multi-collinearity of the variables. On Table VI I report the results of using the parameter estimate to compare the annual cost of excess capacity, with the expense of duplicative poles and conduit. The results are reported on .

Based on the parameter estimates from model three, if only one supplier had served competitive points, the fixed average cost per Bell subscriber would have fallen from $1.51 to $0.78. If the Independent firm acquired Bell, the fixed annual cost per Independent customer would have fallen from $1.38 to $0.78. This potential saving of about seventy-three cents per subscriber is less than five percent of the approximate $19.50 marginal annual cost-of-service.

Conclusion

Gansey Johnston wrote in 1908 that "[c]ompetition in the telephone business, as in others, entails waste." Johnston added that he did not believe that the waste in telephony was larger than in unregulated

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[34]I assume that the price of capital does not vary across exchanges. Unlike with the purchase of capital equipment, labor prices may vary across exchanges due to differences in local markets. As shown in the appendix, the hypothesis that the annual cost of service is independent of the price of labor is rejected for models 1 and 3, but accepted for model 2 at the five percent level of significance. At the one percent level of significance, for both models 1 and 2, I accept the null hypothesis that the price of labor does not have a statistically significant impact on the cost-of-service.

Once that rivalry was eliminated, regulation failed to provide a similar incentive.

The take-off in telephones per capita did not occur in nations served by only one telephone company. As shown in Figure One, telephone penetration was comparable in Europe and the United States until Bell's patents expired. Subsequently, growth in the United States out paced Europe's development. The difference was due in part to the restrictions placed on European telephone development by the states' telegraph companies [Duch 1991; Noam 1991]. But this only accounts for part of the difference, for as shown in Figure One, the initial growth of telephony in the United States was not substantially different than Europe's.

The two European nations with the highest development, Sweden and Denmark, had some form of competition. In Sweden, there was intense rivalry. Stockholm was served by a privately owned, as well as a publicly controlled telephone company. Noam reports that this "rivalry led to reduced rates, high technical performance, and experimentation by the government with new types of service and billing...making Stockholm's telephone system the most advanced in the world [1991]. In Denmark, regional telephone companies did not directly compete, but the existence of multiple suppliers provided a competitive benchmark which the public used to "compare local service and to pressure for improvement in lagging performance" [Noam 1991].

Appendix

I have assumed that the price of capital equipment did not vary across exchanges. Wisconsin Telephone purchased its equipment from Western Electric and therefore there should be no variation in capital input prices across exchanges.

It is unclear if the price of labor varied across exchanges. Arguably, since labor was acquired in a regional market, there should be little or no variation in labor prices across exchanges. Furthermore, through its

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Table II:Commission Valuation of Plant Versus Book Value

City	Commission's Valuation, Cost, New	Book Value	Ratio, Commission's Valuation to Book	Competition
Burlington	$18,993	$18,993	100%	No
Columbus	19,465	21,360	91	No
Hortonville	10,778	10,778	100	No
La Crosse	163,309	240,600	68	Yes
Marinette	60,814	63,712	95	No

Table IV: Impact of Competition on Wisconsin Telephone's Capital Stock

	Model 1	Model 2	Model 3
Mobility Barriers	222,471	426,941	188,847
Duplication of Structural Investments	187,767	331,812	154,476
Ratio (Mobility/Duplication)	1.18	1.29	1.22

Table Table VI: Impact of Competition on Wisconsin Telphone's Annual Cost-of-Service

	Model 1	Model 2	Model 3
Mobility Barriers	50,247	108,285	37,367
Duplication of Structural Investments	36,193	75,344	22,092
Ratio (Mobility/Duplication)	1.39	1.43	1.69

Table Table VIII: Impact of Competition on Wisconsin Telephone's Annual Expense

	Model 1	Model 2	Model 3
Mobility Barriers	31,007	107,013	37,208
Duplication of Structural Investments	42,761	71,222	40,757
Ratio (Mobility/Duplication)	.725	1.50	.91