

Personal and Financial Networks in the US Electric Utility Industry
Before the First World War

By

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Abstract

This paper uses data from a 1916 U.S. Department of Agriculture report to study the extent of personal, local networks in the U.S. electric utility industry. Personal networks were important devices, used to transmit information among actors in the industry. This information could be both technical and financial. Because the industry was extremely capital intensive, especially in its earlier years, the role of finance was exceedingly important and a constant source of concern to those in the industry. Likewise, the financial community would have great interest in the health and wellbeing of the firms to which they had loaned money. Thus, the potential relationships between actors in the electric utility industry and actors in the financial community are of interest. Data on interlocking officers and directors, in both utilities and financial institutions, are used to identify networks. The paper focuses on Boston and, to a lesser extent, New York, the two largest financial centers in the U.S. at the time. The data show that utilities were intimately linked to each, were also linked to their financiers, that the financial markets were very tightly linked locally, and that the Boston and New York financial markets were linked to each other, although much less tightly. The implication is that information of all types, both good and bad, could be transmitted quickly with few intervening connections among all the actors in the industry in both cities.

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European Business History Conference
Barcelona, 16-18 September 2004

Capital Intensity¹

The process of generating, transmitting, and distributing electricity by central-station utilities has always taken place through wires configured as spatial networks. Although there still is no national grid in the United States, the level of regional interconnection in most parts of the country is substantial. This electricity network was constructed, actually rather haphazardly, over the past century and a quarter by the firms in the industry, most of which were privately owned but with a substantial minority of publicly-owned enterprises.² These firms, of course, were owned and managed by individuals who made decisions about the choice of technology and construction of physical networks. The main question addressed in this paper is the extent to which, at least in Boston and New York in the early twentieth century, it can be shown that these individuals formed a business or “social” network.³ The formal study of social networks has gained considerable momentum in the last several decades.⁴ My intent here is not to perform a formal quantitative test of the networks being considered; rather it is to establish the likely existence of these networks. Formal testing is reserved for the future.

The equipment needed to generate, transmit, and distribute electricity had distinctive economic characteristics. It was expensive, relatively complicated, depreciated quickly, and was

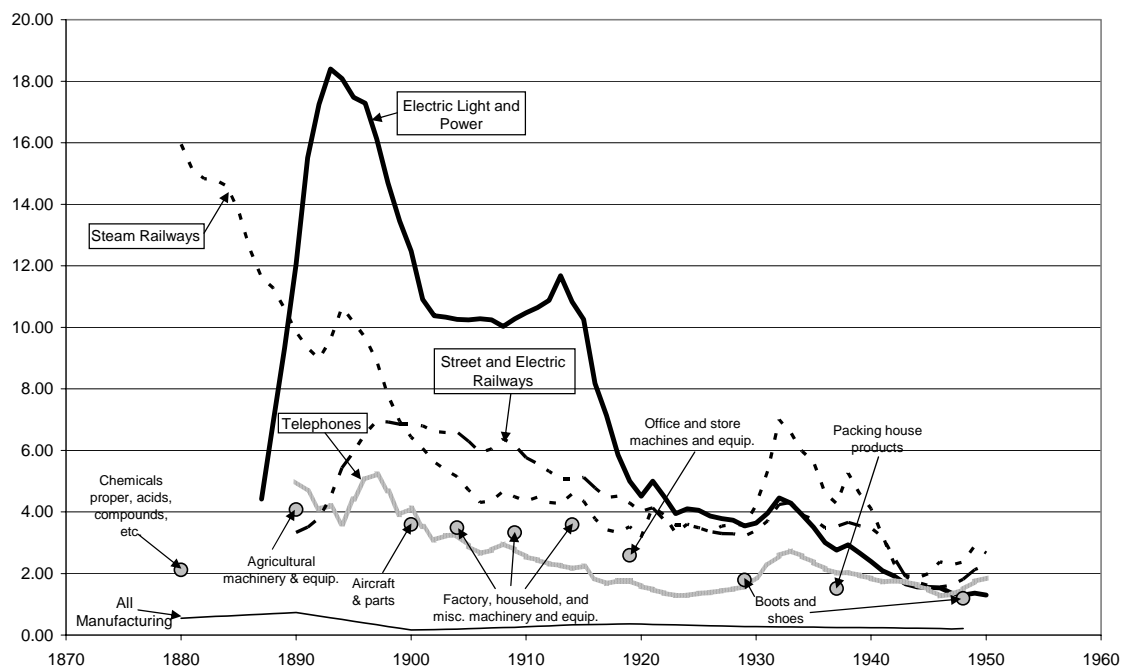
¹ This paper is a revised version, with analysis of additional data, of William J. Hausman, “Webs of Influence and Control: Personal and Financial Networks in the Formative Years of the US Electric Power Industry,” *Annales historiques de l’électricité*, no. 2, June 2004, pp. 53-67.

² The network remains susceptible to costly and extensive breakdowns, the most recent one in August 2003 that covered several Midwestern and Northeastern states and much of Ontario, Canada. *Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations* [<http://www.nerc.com/~filez/blackout.html>, accessed April 26 2004].

³ The paper will not address the extent to which these individuals socialized outside of business. Since they usually lived in the same cities, and often were prominent members of the community, they well could have belonged to the same clubs, charitable organizations, political parties, or churches.

constantly evolving. The most salient feature of the supply-side of the industry was that it was extraordinarily capital intensive. The relative capital intensity of the electric power industry is illustrated in Figure 1. This figure presents capital/output ratios for steam railways, electric light and power stations, street and electric railways, telephones, select manufacturing industries, and all manufacturing. With the exception of steam railways during the formative years of that industry, no other public utility or manufacturing industry came close to approaching the capital intensity of the electric power industry from its beginnings in the late nineteenth century up to World War I.

Figure 1. Capital/Output Ratios for Utilities, Transportation, and Manufacturing



⁴ Henk Flap, "No Man is an Island: the Research Programme of a Social Capital Theory," in Olivier Favereau and Emmanuel Lazega, eds., *Conventions and Structures in Economic Organization* (Cheltenham, UK: Edward Elgar, 2002), p. 29. Also see articles in the Sociology journal, *Social Networks*.

The Role of the Financier

The high capital intensity of the electric power industry had several major implications that helped determine its structure and growth. First, the industry obviously had relatively high *initial* capital costs that had to be met in order for a utility to even exist. Not only were capital costs high, but a substantial amount of capital had to be raised before *any* electricity could be produced.⁵ Annual interest payments on those fixed costs had to be met in order to attain profitability. Initial investment, obviously, but also expansion, could not be financed out of retained earnings, and outside sources of funds were needed. This was not always easy, for starting a utility was perceived to be a very risky proposition in the early days, and access to capital was essential in order both to enter the business and to expand it. The need for a pool of initial capital, and the constant need for ever-increasing capital, led to both traditional financing methods (issuance of stocks and bonds) and to the design of imaginative ways of attracting new investment, primarily through the use of leverage via holding companies.⁶ The position in the early days was aptly summed up by Samuel Insull, Thomas Edison's secretary and manager of several of his companies, who later became President of Commonwealth Edison (Chicago) and founder of Middle West Utilities (a large, multi-state holding company):

It should be remembered that at this time the manufacturing side of the electrical business was apparently more profitable. The central station side of the business, whilst showing a return on its investment, was of

⁵ In the early days of the industry electrical manufacturers like Thomson-Houston and Edison General Electric accepted the stocks and bonds of newly-formed operating companies as payment for equipment. See W. Bernard Carlson, *Innovation as a Social Process: Elihu Thomson and the Rise of General Electric, 1870-1900*, New York, Cambridge University Press, 1991, p. 214.

necessity very much slower in its development because of the large capital required for it as compared with the manufacturing business. The difficulties in raising capital were great, because financiers had yet to acquire the necessary confidence in the permanency and remunerative character of the electric lighting central station business.⁷

Financiers, including banks, trust companies, insurance companies, and investment banking houses, were essential to the success of the industry, and they played an important role in its development. But the relationship was not one-sided; it was reciprocal. The electric power industry provided a potentially lucrative outlet for investment funds as well as for the generation of substantial supervisory and financial commissions. It was a potentially lucrative source of revenue for financiers. The clear implication is that the electric utilities and their financiers should have been intimately linked, with common interests and tight personal networks. Because financiers sought an adequate return on their investment, they were profoundly interested in the operation of utilities and in the structure of the industry (including its stability and expansion). One important, formal mechanism by which monitoring and information sharing could take place was through interlocking directorships.

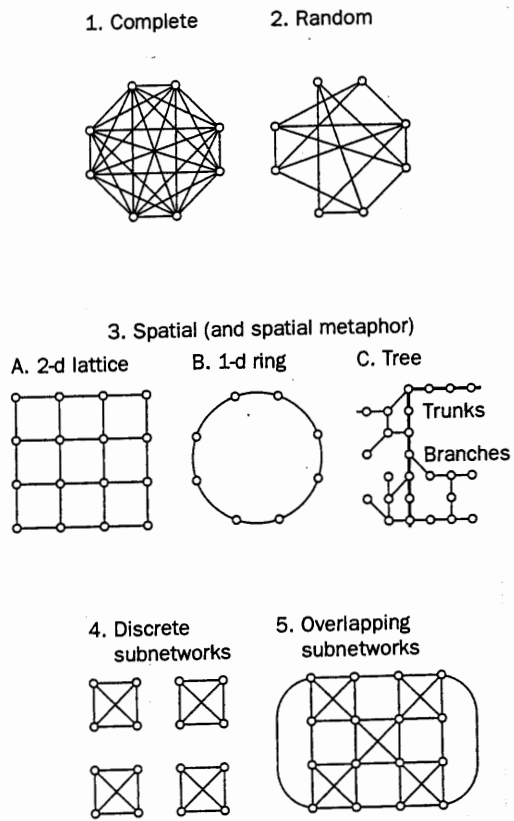
Ideal Network Types

Douglas J. Puffert has recently suggested eleven possible network structures in which

⁶ See Sidney A. Mitchell, *S.Z. Mitchell and the Electrical Industry*, New York: Farrar, Straus & Cudahy, 1960, pp. 79-80, for a discussion of how leveraging in holding companies was expected to work.

⁶ Samuel Insull, *The Memoirs of Samuel Insull*, ed., Larry Plachno, Polo, IL: Transn Trails, 1992, p. 61.

Figure 2. Puffert's Network Forms



Source, Puffert, "Path Dependence," p. 74.

direct interactions among network users or providers of network services can take place.⁸ This taxonomy can be applied to cases of electric utility and utility/financial network interactions when using interlocking directors and officers as the actors making the connections. It is not the technology that is of interest here, but the flow of information about the technology and other issues. Each firm (electric utility or financial institution) represents a node and a director or officer in common represents a link. Five of the eleven possible structures suggested by Puffert seem potentially relevant and are presented in Figure 2. Puffert defines a complete network (type 1) as one that features direct interaction between all nodes, while a random network (type 2) has only the possibility of interaction between any two nodes; it is much less dense. Spatial networks (type 3) are much more limited, featuring direct links only between immediate neighbors, although the form of the network can vary considerably. Networks may also be described as having discrete, non-connected sub-networks (type 4), or connected sub-networks (type 5). I will show below, graphically, that the electric utility industry, the financial industry, and the relationships between the firms in the two industries, have aspects of type 1, type 2, and type 5 networks, the particular type being conditional primarily on the geographical area under consideration.

The Data

The data on officers and directors used to assess potential network configurations comes from a report by the United States Department of Agriculture, which was a response to a request by the United States Senate to the Secretary of Agriculture to “furnish the Senate with all

⁸ Douglas J. Puffert, “Path Dependence, Network Form, and Technological Change,” in *History Matters*, ed. Timothy W. Guinnane, William A. Sundstrom, and Warren Whatley, Stanford: Stanford University Press, 2004, pp.

information in his possession as to the ownership and control of the water-power sites in the United States, ...[along with] any facts bearing on the question as to the existence of a monopoly in the ownership and control of hydroelectric power in the United States.”⁹ This inquiry took place shortly after a Congressional committee headed by Arsène Pujo had investigated the existence of a “money trust.”¹⁰ The search for monopoly was an obsession for some at the time, and this is an example of that “Progressive” sentiment. The Secretary of Agriculture complied with the Senate request and issued a three-part report in 1916, noting that in order to answer the question regarding water power it was necessary to collect information on all electrical developments in the country, which was a rather substantial undertaking.¹¹ The result was impressive.

The report contains a wealth of raw data, including information on concentration at the national and state levels, and ownership and control, both direct (through ownership of subsidiaries) and indirect (by means of interlocking corporate officers and directors) in the industry. The importance of finance to the industry was explicitly recognized: “A control of the sources of credit would mean a control of the entire industry, would be the most effective means of stifling competition, and, regardless of how well the industry might be controlled in its service

63-95.

⁹ United States Department of Agriculture, *Electric Power Development in the United States*, United States Senate, 64th Congress, 1st session, Document No. 316, Washington: USGPO, 1916, part 1, p. 11. (This source is cited hereafter as USDA, 1916.)

¹⁰ The most eloquent Progressive statement regarding the alleged money trust was Louis D. Brandeis’s *Other People’s Money and How the Bankers Use It*. Originally published in *Harper’s* weekly magazine in 1913 and 1914, it has been reprinted many times. A recent edition with an excellent introduction is Louis D. Brandeis, *Other People’s Money and How the Bankers Use It*, Boston and New York, Bedford Books of St. Martin’s Press, 1995.

¹¹ The United States Bureau of the Census had been collecting and publishing detailed data on the industry every five years beginning in 1902. However, the data were aggregated at the state level and thus no information on individual electric power companies was included.

operations by public agencies, would leave the opportunities of engaging in the business and the initiation of new enterprises in the hands of the few.”¹² However, the report contained no hysterical denunciation of concentration of ownership, and it even acknowledged a potentially positive aspect of concentration: “This particular tendency toward concentration need by no means be of ill omen. Monopolization of the supply in any given territory makes possible through interconnections of stations and through diversification of load, economies of operation that would not be possible for isolated independent stations.”¹³ This, of course, refers to the technological linking of the physical network in a particular locality. In fact, by the time of the report most urban areas were served by a single, monopoly firm, although street railways sometimes competed for business. This did not completely ameliorate the nearly constant need for new funds. In the end, the report did express the view that, more than any other factor, the “great concentration of power development under present conditions...[depends on] control of the markets and control of the sources of credit.”¹⁴ Again, the electric utility industry and finance are intimately linked.

Volume 3 of the report contains the information on interlocking officers and directors. The data are presented in several forms. There is a 138-page table that lists electric utilities, industrial companies having connections to electricity production (companies like International Paper, for example, that operated electrical facilities), and financial institutions with links to electric power companies. Under each company is listed other companies, including financial

¹² USDA, 1916, part 1, p. 53. The authors of the report were particularly concerned that entry of new firms was sacrificed in favor of the expansion of existing firms.

¹³ USDA, 1916, part 1, p. 55.

¹⁴ USDA, 1916, part 1, p. 62.

institutions, in which there are common officers or directors, including the number of the officers and directors in common between two firms.¹⁵ In fact, the authors of the report state that the entire set of companies can be viewed as an extensive network: “Every company named in the following tabulation is directly or indirectly related to every other company, such relationship occurring through common directors or principle officers, or through lease, stock ownership, or some other form of control.”¹⁶ To express the relationships in a different way, there follows a 90-page table listing the officers and directors of electric power companies, financial institutions, and manufacturing companies with a connection to electric power, with their place of residence and the executive positions and directorships held. This provides the raw material from which the connections between companies in a particular geographical setting can be made. A subset of the information in these two, massive tables is also presented in three large, fold-out matrices, showing the number of interlocking officers and directors between pairs of companies. Finally, the report illustrates some of the relationships by graphically summarizing the connections for the major utility holding companies and operating utilities. Figure 3 reproduces the Stone & Webster Management Association (Boston) diagram, where each line represents an officer or director in common. While difficult to interpret, the connections are clear, and the diagram, with its connected sub-networks, appears to be consistent with Puffert’s “type 5” network. The direct connections between Stone & Webster, for example, and the operating utilities it managed and controlled (such as Galveston-Houston Electric Co., Mississippi River Power Co., Puget Sound Traction, Light & Power, etc.) are obvious, but there are also indirect connections (most with

¹⁵ Most of the basic material was compiled from *Moody’s* and *Poor’s* investment manuals for 1914. For a random sample of ten companies, there were an average of 27 links to other power companies (range = 5 to 52) and 9 links to financial institutions (range = 1 to 25).

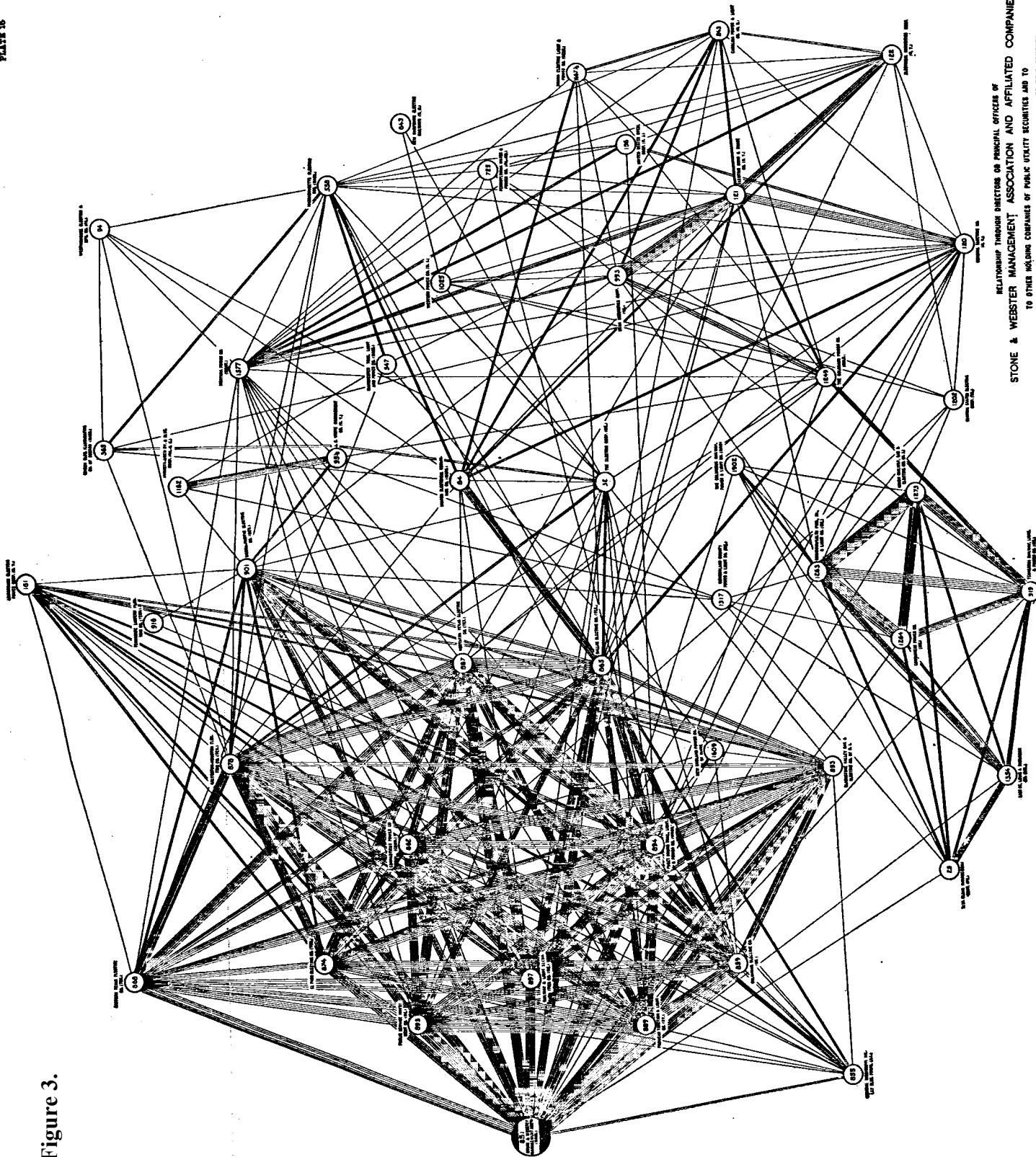


Figure 3.

RELATIONSHIP THROUGH DIRECTORS OR PRINCIPAL OFFICERS OF
STONE & WEBSTER MANAGEMENT ASSOCIATION AND AFFILIATED COMPANIES
 TO OTHER HOLDING COMPANIES OF PUBLIC UTILITY SECURITIES AND TO
 INDUSTRIAL COMPANIES OWNING, OPERATING OR CONTROLLING WATER POWER DEVELOPMENTS

NOTE:—THIS LIST OF RELATIONSHIPS WAS PREPARED BY THE STONE & WEBSTER MANAGEMENT ASSOCIATION AND AFFILIATED COMPANIES AND IS NOT INTENDED TO BE A COMPLETE LIST OF ALL RELATIONSHIPS. THE LIST IS INTENDED TO BE A SUMMARY OF THE RELATIONSHIPS WHICH ARE KNOWN TO THE STONE & WEBSTER MANAGEMENT ASSOCIATION AND AFFILIATED COMPANIES.

only two degrees of separation; that is, needing only two links to make a connection) to other major utility holding companies (J. G. White, E. W. Clark, and Electric Bond & Share), the two major electrical equipment manufacturers (General Electric and Westinghouse), and some major independent operating utilities (Boston Edison, for example). The Stone & Webster network was quite complex. By combining a small number of these diagrams, every major electric power company in the United States can be linked with no more than two or three degrees of separation to every other firm.¹⁷ One of the implications of this is that an innovation – in technology, management, pricing, marketing, etc. – in any firm in the network, large or small, could be transmitted nearly universally and very quickly through the whole network.¹⁸ Any problems an individual firm was having also could be transmitted quite quickly.

Utility and Financial Networks: Boston and New York

The focus of this paper is on Boston, and to a lesser degree, New York City. Starting from the list of officers and directors, I decided to focus on Boston because it appeared to be manageable (compared to New York, for example), had both a major urban electric utility and fringe of smaller utilities, was home to Stone & Webster, a major multi-state utility management, finance, and service company, and was a notable financial center, second only to New York, with powerful banks, trust companies, and investment houses. I then expanded the inquiry to

¹⁶ USDA, 1916, vol. 3, p. 9.

¹⁷ These so-called “small-world” phenomena are beginning to be studied in a formal sense, with sociologists leading the way. See, for example, Duncan J. Watts, “Networks, Dynamics, and the Small-World Phenomenon,” *American Journal of Sociology*, 105 (Sept. 1999), pp. 493-527.

¹⁸ As Chung has pointed out, information also could be exchanged and social norms promulgated at the annual and various regional meetings of the two major electricity trade associations, the National Electric Light Association and the Association of Edison Illuminating Companies. He further argued that these associations themselves constituted a social network. Chi-nien Chung, “Networks and Governance in Trade Associations: AEIC and NELA in the

include some major New York financial institutions to see if they could be tied to the Boston firms. From the table containing the alphabetical list of officers and directors in the USDA report, I entered into an Excel spreadsheet every person residing in Boston and the firms on whose boards they served.¹⁹ This resulted in a list of 131 individuals with executive positions or seats on the boards of 217 electric power companies in 26 states. These individuals also sat on the boards of 117 financial institutions, the vast majority of which were in the Boston area but also including ones in New York, Philadelphia, Utah, and Colorado (but none in Chicago or San Francisco, for example). These individuals also were officers or directors of 34 manufacturing or mining firms in 12 states. This indicates that Boston capitalists were quite active, and not just at home, but it still says little about how they may have served as links between the various companies; that is, whether they constituted a network.

To address the question of network connectedness it was necessary to determine directors in common among the firms.²⁰ Again, in order to make the project manageable, the analysis was limited to Boston-area electric power companies and financial institutions, so this should be considered a geographically local study. This reduced the number of electric utilities under consideration by more than half to 79, and the number of financial institutions to 81. Among those 79 electric power companies there were a total of 1,413 individual links (one or more common directors or officers) between two companies. Only four of the companies remained isolated and had no links to other companies. For illustrative purposes, a data matrix for a subset

Development of the American Electricity Industry 1885-1910," *International Journal of Sociology and Social Policy*, 17 (1997), pp. 57-110

¹⁹ There were a number of non-Boston residents on the boards of the Boston-area utilities. These officers and directors are not considered using this technique.

²⁰ This was done using Microsoft Access.

of these companies is presented in Table 1. When firms that were clearly related by ownership were eliminated from the data, there remained 34 apparently independent companies, with 59 individual links, or 1.7 director links per firm, representing a much lower level of density. However, only four companies remained totally isolated. I believe that the extent of these connections makes it clear that the Boston-area electric utilities comprised a network.

But the utility-to-utility links were only one aspect of the network, and perhaps not the most salient. Given the critical importance of financing to the industry, the utility to financial institution links may have been even more significant. Returning to the full set of Boston area electric power companies (79) and Boston financial institutions (81), the number of direct links, again, is quite impressive. There were 430 directors in common, or roughly 5.4 per firm. A casual examination of the matrix confirms that nearly every major Boston financial institution was included in the network (that is, had at least one link to at least one electric utility). Seventeen of the eighteen largest national banks, trust companies, and savings institutions in the city were included.²¹ Old Colony Trust Company, by far the largest trust company in Boston had 33 links to electric power companies, and the Provident Institution for Savings, the largest savings bank had 22 links. The Boston national banks tended to have fewer links, most likely because they were not engaged in long-term financing to the same extent as the other financial institutions.

Table 2, for illustrative purposes, presents a subset of the links between electric power companies and financial institutions, which are frequent. It also makes sense to establish the

²¹ Howie lists Boston's financial institutions with deposits and assets as of 1926. Wendell D. Howie, "A History of Banking in Boston," in Albert P. Langtry, ed., *Metropolitan Boston: A History*, vol. II, New York, Lewis Historical Publishing, 1929, pp. 331-443

links between the financial institutions themselves, since that is where much of the information about the industry would be transmitted and exchanged.

Table 3 demonstrates just how closely the major Boston financial institutions were tied to each other; they formed a very dense network with multiple interconnections. The financial community clearly had the potential to share information quickly when it needed to. It was unlikely that bad news could be hidden, and appropriate new techniques could be disseminated as well. As a whole the electric utilities and financial firms were knitted together by many common officers or directors which constituted an extensive personal network enmeshing the actors in these industries located in the city of Boston.

As evidenced in the tables presented thus far, there were a substantial number of small firms in the electric utility industry at this time, as well as many smaller financial institutions. In this section I turn attention to some of the largest actors involved in the industry (in Boston) to see how tightly they were connected. Figure 4 presents the interconnections between Boston's most prominent electric utilities and its major financial institutions. Boston Edison was the largest electric utility in the state of Massachusetts; Stone & Webster was the third-largest multi-state utility holding company in the United States; Old Colony Trust Co. and the First National Bank, respectively, were the largest trust company and bank in Boston; Kidder, Peabody & Co. and Lee, Higginson & Co. were prominent Boston investment banking houses, with Lee, Higginson specializing in utility finance. The interconnections are clear among all the actors. Boston Edison and Stone & Webster are closely linked, making it likely that information could flow freely. They are both connected directly to Old Colony Trust and the First National Bank and indirectly, through those financial institutions, to the investment banking houses. Old Colony Trust and the First National Bank, with nine officers or directors in common, were very tightly connected. This configuration of the firms makes it look very much like a network somewhere between Puffert's "type 1" and "type 2" networks, not quite complete but more than random and certainly dense enough for information to flow. But was the network purely local, limited only to Boston? The inclusion of the Guarantee Trust Co. of North America in this chart represents one link tying the Boston network to the outside world, particularly New York, the largest financial center in the United States.

Figure 4. Major Boston Electric Utilities and Financial Firms

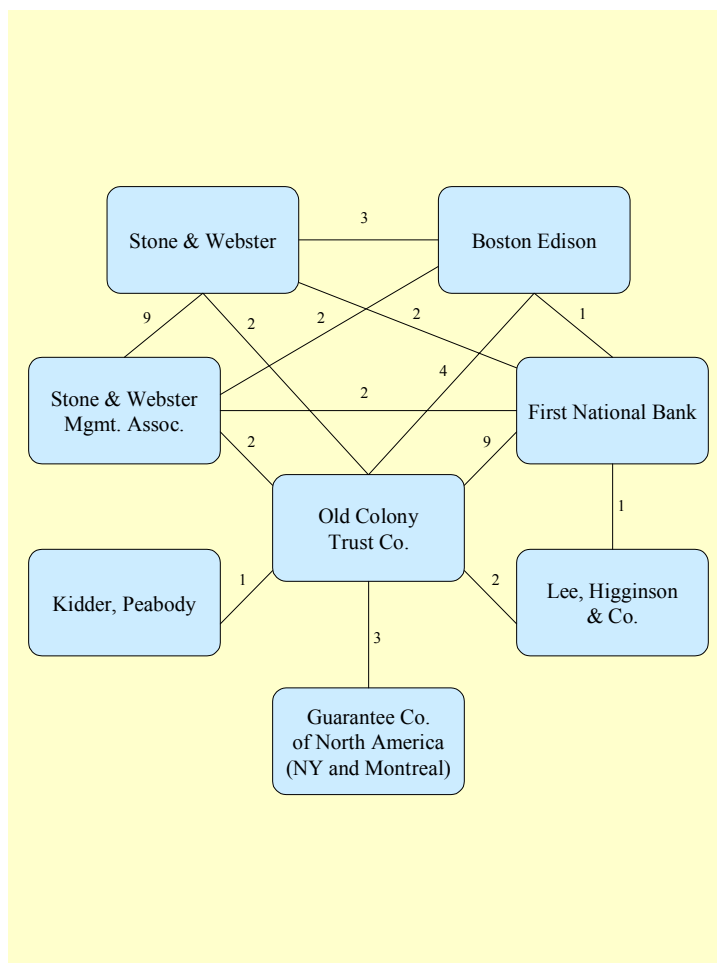


Figure 5 presents connections between the four largest commercial banks and four largest trust companies in New York in 1914.²² These firms come very close to forming a nearly complete (“type 1”) network. In addition, the prominent investment-banking house of J. P. Morgan and Company was tied to six of the eight firms as well as the Guarantee Company of North America. The Guarantee Company of North America formed a “bridge” between the major utilities and financial institutions of the two cities.²³ This is represented in Figure 6. Information may not have been able to flow as fast as in either of the local networks, but the connections existed.²⁴ A Boston firm shut out of the Boston financial market for legitimate (or possibly illegitimate) reasons would not be likely to have success raising funds in New York.

²² This information is taken from Plate III, “The Inter-Relationship of Certain Financial Institutions which through their Directors are Interested in Public Utility and Industrial Companies engaged as or holding Securities of Electric Power Public Utilities” (attached to Volume 3) of the USDA Report. There were 442 links (15 per firm) for the 29 Boston financial institutions included and 1,326 links among 74 institutions (18 per firm) for the New York financial institutions included. There were 72 links between Boston and New York firms. Information on the size of New York financial institutions is from *The Commercial and Financial Chronicle*, vol. xcvi, March 28, 1914, p. 977.

²³ David Knoke and James H. Kuklinski, *Network Analysis*, Sage Publications, Beverley Hills, Calif., 1982, p. 42.

²⁴ While the connections clearly were not as dense between the financial institutions of the two cities, only four of the 26 Boston financial institutions listed in Plate III had no connection to a New York financial institution.

Figure 5. Major New York Financial Firms

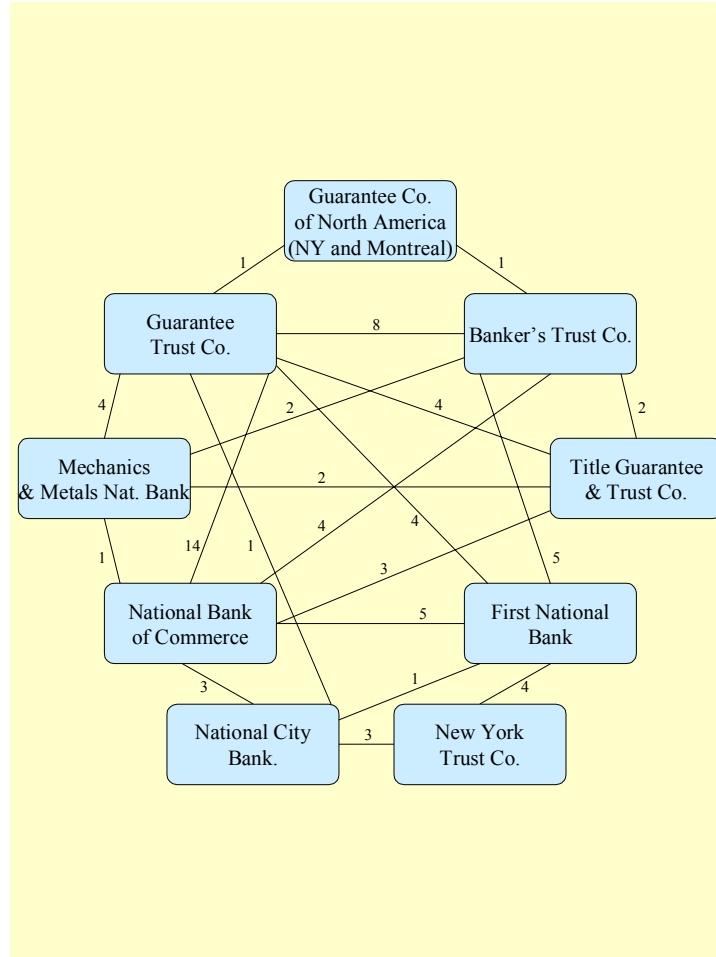
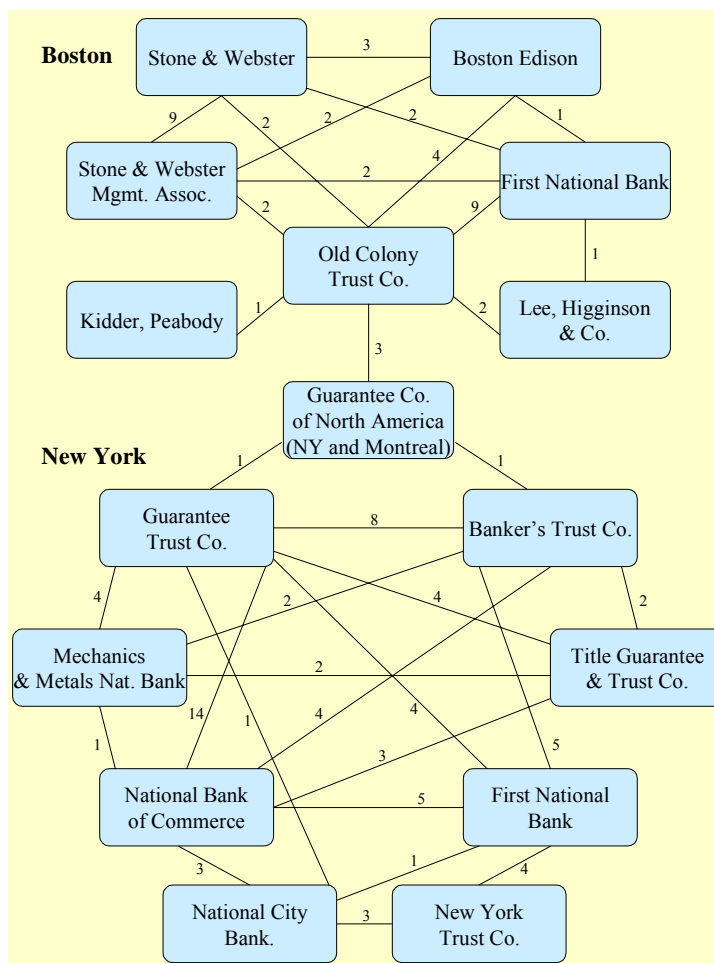


Figure 6. Links between Boston and New York



Conclusion

The authors of the United States Department of Agriculture report on concentration in the electric utility industry collected information on nearly 2,100 electric utilities and hundreds of financial institutions. Summarizing the vast amount of information was a challenge. The report presented material diagrammatically and in long tables and large matrices, awkward and difficult forms to interpret, but nonetheless impressive. I have manipulated and arrayed the data in the report to show how interconnected utilities and financial institutions in the Boston area were, and how they could be connected to the New York financial market. The confirmation of the

connection between the utilities and the financial institutions was perhaps the most important finding of the analysis. This connection would have been crucial to both parties, to utilities seeking funding and to the financiers interested in monitoring the industry where their funds were invested. This was an era when the industry was still growing and struggling for capital, when less than half of urban Americans were connected to central stations,²⁵ and when information was important. The existence of local networks, such as existed in Boston, would have permitted all kinds of positive information, from technical breakthroughs to marketing discoveries to effective new pricing schemes, to have flowed. On the other hand, bad news also would have flowed, giving a firm facing difficulties nowhere to hide. Without such networks raising capital most likely would have been much more difficult.

²⁵ United States Department of Commerce, Bureau of the Census, *Historical Statistics of the United States*, Washington: USGPO, 1975, part 2, p. 827.