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The Market for Capital and the Origins of State Regulation of Electric Utilities in the United States

WILLIAM J. HAUSMAN AND JOHN L. NEUFELD

We provide evidence that the problem of raising capital in the early days of the U.S. electric-utility industry motivated industry leaders to embrace state rate-of-return regulation in return for a secure territorial monopoly. Utility executives anticipated that this would lead to a reduction in borrowing costs. Using firm-level bond data for 1910–1919, we estimate a model and find that state regulation led to lower borrowing costs but that the magnitude of the reduction was small. We also find evidence that output of electric utilities in states with regulation was higher than output in states without regulation.

The evolution of the electric-power industry in the United States has been heavily influenced by the institutional structure under which it has operated. Beginning in the first decade of the twentieth century, electric utilities in an increasing number of states were subjected to rate-of-return regulation. Today, most privately owned electric utilities in the United States must have the prior approval of state regulatory agencies to build new capacity, to change rates, and (in many states) to seek new financing through the capital market.[1] This type of regulation, based on extensive investigation of each company's particular situation, is unique to the United States.

In many countries around the world, electric-utility industries have recently been restructured or are in the process of restructuring. In the United States there is a similar movement, which seeks to bring substantially more competition to the industry.[2] Because the existing institutional framework

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[1] In 1998 privately owned utilities generated and distributed approximately 68 percent of the electricity in the United States. Publicly owned utilities, cooperatives, federal power agencies, and nonutility generators provided the remainder. U.S. Department of Energy, *Changing Structure*.

[2] The restructuring process was stimulated by passage of the Energy Policy Act of 1992. The fact that policies are only now being implemented is in part due to the need to deal with state regulatory apparatuses. As of February 2002, 17 states had enacted restructuring legislation or issued comprehensive regulatory orders for restructuring. The recent energy crisis in California has caused eight states to either suspend or delay restructuring. The Energy Information Administration maintains data on the status of restructuring in the states (http://www.eia.doe.gov). Information on this process also can be

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in the United States is unique, however, the problems faced in moving to a new, competitive framework are distinctive, and proposed changes in the industry need to be considered in light of its history, particularly that of the development of state regulation.[3]

Rate-of-return regulation by states, and later by the federal government, was devised originally to deal with railroads. In fact, some states simply turned responsibility for the regulation of electric utilities over to existing railroad commissions. There has been considerable historical debate over the motivation for the political decision to regulate U.S. railroads.[4] The nature of the railroad debate has largely involved whether regulation was meant to protect consumers (public-interest theory) or to enable railroads to extract monopoly profits from consumers (capture theory). Both sides of the debate focus on pricing in the market for railroad services. Scholars have paid considerably less attention to why electric utilities came to be regulated, but the few studies on the establishment of electric-utility regulation similarly assume that it was designed to affect the market for electricity.[5] In this article we consider another possibility: it was not the market for *electricity* that was the object of regulation but the market for *capital*. We hypothesize that electric-utility executives came to favor the institution of state regulation not out of an expectation that it would enable them to raise rates to consumers or extract monopoly profits, but primarily because regulation would help alleviate their severe financing problems.[6]

The problem of raising capital in the early days of the electric utility industry (prior to the adoption of regulation) was enormous, a condition that may have retarded the nation's electrification, and one that has not been fully appreciated.[7] Regulation reduced the risk of investing in an electric utility, thus making utility bonds and stocks more attractive, increasing the availability of capital, and lowering its price. Consumers benefited as well because increased investment enabled the production of more electricity,

found at http://www.si.edu/nmah/csr/powering/ ("Powering a Generation of Change"). This site, whose purpose is to document the transition process, is maintained by the Division of Information, Technology, and Society at the Smithsonian Institution's National Museum of American History. It also contains a substantial amount of historical information.

[3] In the case of Britain, for example, the government was able to design, in the late 1980s, and implement, in March 1990, a single national policy regarding the industry.

[4] On the history of railroad regulation see, for example, Kennedy, "Statist Evolution"; or Berk, "Adversaries." On state versus federal regulation, see Kolko, *Railroads*, pp. 166, 217–23.

[5] The classic articles on this subject are Stigler and Friedland, "What Can Regulators Regulate?"; and Jarrell, "Demand." For a general account of the rise of electric utility regulation see Anderson, *Regulatory Politics*, Ch. 2; and Hirsh, *Power Loss*, Ch. 1.

[6] Utility executives undoubtedly had mixed motives for advocating regulation. Another motivation for regulation was to forestall the municipal ownership movement. This point was made explicitly by E. W. Burdett in an address to the National Electric Light Association in 1906. Burdett, "Agitation."

[7] By some standards, the spread of electrification was not particularly rapid. As late as 1920 fewer than 50 percent of the nation's urban and nonrural homes were electrified. U.S. Department of Commerce, *Historical Statistics of the United States*, Part 2, p. 827.

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which, in an era in which there were substantial economies of scale, lowered its price.[8]

In our investigation of the movement for state regulation and its effect on financing electric utilities, we first document the problem utilities faced in acquiring capital; we then review the public debate that led to the adoption of state regulation, with the object of presenting evidence from that debate that bears on the relationship between regulation and financing; and finally, we conduct an econometric analysis designed to test for the effects of state regulation on financing electric utilities. The quantitative analysis cannot determine why regulation was adopted, but it can tell us if regulation had the expected (positive) effect in the capital markets in which electric utilities operated. We find statistically significant evidence that regulation led to lower borrowing costs for electric utilities, although the decrease in costs was relatively small in magnitude. We also find evidence that the output of electric utilities in states with regulation was higher than ouput in states without regulation.

THE PROBLEM OF CAPITAL ACQUISITION IN THE EARLY DAYS OF THE INDUSTRY

Electric power generation, transmission, and distribution have always been highly capital-intensive endeavors. Table 1 presents data indicating that in the period under discussion, the ratio of the value of capital to the value of output was the highest among a wide array of industries. In the earliest days of the industry, the problem of raising capital was critical for success, a point Thomas Edison dramatically illustrated when he inaugurated his commercial electric service by gathering the press and publicly switching on the lights for the first time in September 1882 in the office of his financier, J. P. Morgan.[9] Sidney Z. Mitchell, who later became one of the most prominent electric utility executives in the country, noted of the early days:

> Money has always been the greatest problem in the electrical industry where an unusually high investment is required to produce one dollar's worth of sales. This ratio has varied between $4 and $8 of investment for each $1 of gross sales. And, when this is added to the growth characteristic of the industry, an annual increase of sales of 6 to 8 per cent compounded each year, one can have some understanding of the additional money continuously required.[10]

By 1902 the roughly 2,800 privately owned electric utilities in existence had invested a total of $483 million in construction and equipment (cumulative since 1882), but were generating annual revenues of only $79 million and profits of roughly $16 million.[11] Yet the industry continued to grow

[8] Figures for the nominal and real price of electricity can be found in Edison Electric Institute, *Historical Statistics*, p. 165.

[9] A detailed description of the events of that day can be found in Jones, *Power History*, pp. 177–79.

[10] Mitchell, *S. Z. Mitchell*, p. 45.

[11] U.S. Department of Commerce and Labor, *Light and Power Stations, 1902*, p. 6.

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TABLE 1
RATIO OF VALUE OF CAPITAL TO VALUE OF OUTPUT
(1929 dollars)

Year	Electric Light and Power	Steam Railroad	Telephone	Street and Electric Railway	All Manufacturing	Chemicals	Agricultural Machinery	Motor Vehicles
1890					0.73	2.30	4.08	2.00
1895	17.48	10.17	4.42	5.94				
1900	12.48	6.43	4.12	6.85				
1905[a]	10.24	4.71	2.89	6.30	0.89	2.71	3.49	2.71
1910[a]	10.47	4.35	2.54	5.77	0.97	2.13	3.33	2.02
1915[a]	10.26	4.34	2.23	5.12	1.01	2.30	3.59	1.21
1920[a]	4.51	3.17	1.58	4.01	1.02	1.84	1.72	0.88

[a] One year earlier in the case of all manufacturing, chemicals, agricultural machinery, and motor vehicles.

Sources: Utilities and railways, Ulmer, *Capital in Transportation*, pp. 256–57, 320, 374–75, 405–06, 472–73, 476, 482, 486; manufacturing, Creamer, Dobrovolsky, and Borenstein, *Capital in Manufacturing*, pp. 265–67.

rapidly. Between 1902 (before adoption of state regulation) and 1917 (by which time a majority of states had adopted regulation), the average growth rate in the total value of plant and equipment in the industry was just over 12 percent per annum.[12]

The necessary investment in electric utilities clearly could not be funded out of retained earnings.[13] Capital expenditures had to be financed through issuance of stocks (equity) and bonds (debt), but these securities were notoriously difficult to market for firms in the young electric-utility industry. At this time, utilities were strictly local firms, which did not have national reputations, and the risk to investors was very high. The major manufacturers of electrical equipment devised one way around this problem, with General Electric leading the way. To sell equipment, the electrical manufacturers often accepted payment in the form of their customers' (the operating utilities) capital stocks and bonds. The manufacturers then turned these securities into cash by packaging and marketing stocks and bonds from several different operating companies in the form of an investment trust.[14] Later, other electrical manufacturers, engineering and management-services companies, and investment bankers formed elaborate utility holding companies, which issued

[12] The calculation is based on data in U.S. Department of Commerce, *Light and Power Stations, 1927*, p. 21.

[13] Gross annual investment by electric utilities exceeded total annual revenue (of which earnings is only a fraction) until 1915. Prior to 1910, gross annual investment was more than *double* total annual revenue. Ulmer, *Capital*, pp. 320–21, 476–77.

[14] Charles A. Coffin, vice-president of the Thomson-Houston Electric Company, which merged with Edison General Electric in 1892 to form General Electric, is given credit for originally devising this scheme. Carlson, *Innovation*, p. 214. Carlson argues that even the major electrical manufacturers had difficulty raising capital "because they had become capital-intensive enterprises prior to the development of capital markets suited to large-scale industrial expansion." p. 287.

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their own securities as a mechanism to raise funds and to control a number of operating companies that formed a diverse, nonintegrated system.[15]

Leonard S. Hyman has argued that the problem of obtaining financing was a major factor behind the creation of these companies. He noted that profits to the holding companies came primarily from efficient management of operating companies, which raised the value of security holdings, as well as from service fees of various kinds (including fees for arranging financing).[16] *Moody's* 1914 investment manual, the first one in which public-utility and industrial securities were separated from railway securities, paid considerable attention to the role of holding companies. Because they generally controlled regionally diverse operating companies and were regarded as possessing expertise in issues of engineering, management, and finance, the securities of holding companies were considered to be very safe. *Moody's* also argued that these advantages would benefit their operating company subsidiaries.[17]

THE ADOPTION OF STATE REGULATION

The period prior to the turn of the twentieth century was one of considerable turmoil for the young electric-power industry. Vigorous competition for franchises and for territory was the norm, especially in larger cities. In the Manhattan borough of New York alone, for example, 25 nonexclusive franchises were granted between 1882 and 1900. Twenty-four electric utilities, not all of which actually produced electricity, were established in Chicago between 1883 and 1887.[18] Not only did these utilities face competition from each other, but they also faced stiff competition from the self-generation of power by large users of electricity, which denied the utilities the reduced costs that improved load factors and economies of scale would have brought.[19] Technological innovations also came quickly during this period, contributing to capital costs in the industry by making existing equipment quickly obsolete. A notable example was the alternating current system developed by Westinghouse Electric that eventually replaced Edison's direct current system. These conditions led to financial difficulty in the industry. The pioneering firms in the industry were not very profitable as a whole; average return on investment in 1897 was 4.02 percent, about the same as that for far safer railroad bonds.[20] In addition, privately owned utilities constantly faced the prospect of being bought out or taken over by the munici-

[15] For a discussion of the early history of holding companies see United States Federal Trade Commission, *Control*; and Bonbright and Means, *Holding Company*.

[16] Hyman, *America's Electric Utilities*, pp. 76–77.

[17] Moody, *Moody's Analyses of Investments*, 1914, p. 6.

[18] On New York see Hausman, "Light and Power," pp. 673–75. On Chicago see Platt, *Electric City*, p. 55.

[19] Neufeld, "Price Discrimination."

[20] Hausman and Neufeld, "Structure," p 237.

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pality they served. In 1902 municipally owned utilities constituted almost 23 percent of the total. They tended to be small, however, and their output was less than 8 percent of the industry total.[21]

Franchise competition, the difficulties of raising capital, rapid technical change, and economies of scale in the industry led to a period of local consolidation between roughly 1900 and 1906. During this era many of the large urban utilities still recognizable today were created.[22] Further consolidation subsequently occurred through the mechanism of holding companies, some of which were created specifically to help deal with financing problems.

The development of the electric utility industry occurred during the Progressive Era, whose reformers initially tended to advocate the ownership and operation of utilities by municipal governments, but soon after the turn of the century moved toward advocating state regulation.[23] Considerable discussion about the relative merits of public versus private ownership of utilities occurred during the era. A number of studies were conducted, including one by the U.S. Commissioner of Labor in 1898, and public ownership of electric utilities became a major issue in several mayoral campaigns.[24] In terms of financing, municipal utilities enjoyed an important advantage over privately owned ones; it was easier for them to raise funds at lower interest rates because they could use the city's taxation powers to secure the debts.

At the turn of the twentieth century, many privately owned utilities also were subject to regulation by the municipality in which they were located.[25] The nexus giving the municipality regulatory power arose from the special franchises utilities needed to obtain in order to use the public streets for power lines. The exact forms this type of regulation took varied over time and across municipalities. Initially, cities were inclined to encourage the development of utilities by granting liberal franchises. With the passage of time, it became clear that a utility franchise had value and that a municipality could extract at least some of that value as a condition for awarding the franchise. One approach was to sell franchises to the highest bidder; another

[21] U.S. Department of Commerce, *Light and Power Stations, 1927*, pp. 7, 24.

[22] On the process of consolidation in New York, see Hausman, "Light," pp. 673–75; for Chicago, see Platt, *Electric City*, ch. 2–4; on Kansas City and Denver, see Rose, *Cities*, ch. 1–2; on Boston, Seattle, and San Francisco, see Jacobson, *Urban Utility Networks*, ch. 3; and on Detroit, see United States Federal Trade Commission, *Utility Corporations*, p. 59.

[23] Many Progressives came to believe that municipal politics was excessively corrupt and changed their views. Richard McCormick argues that years of political experimentation and uncertainty around the turn of the twentieth century culminated in what he called the years of "discovery and resolution" in 1905–1908. He notes, "Regulation by commissions seemed to be an effective way to halt corruption by transferring the responsibility for business-government relations from party bosses and legislators to impartial experts." McCormick, "Discovery," p. 271.

[24] United State Bureau of Labor, *Fourteenth Annual Report*. This included campaigns in cities such as New York, Chicago, Boston, and Atlanta.

[25] No comprehensive modern study of this interesting period in utility regulation has been conducted. The noted economist Martin Glaeser provides one of the best discussions of the forms of municipal regulation and the material that follows draws heavily from this source. Glaeser, *Outlines*, pp. 156–310.

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was to demand low rates for street lighting. As pressure developed for municipalities to use their franchise power to benefit the utilities' customers, the awarding of a franchise became a bargain between the municipality and the applicant utility. One historian has suggested that municipal regulation was evolving into the kind of rate-of-return regulation that would be adopted by state commissions.[26] Although there may have been a movement in that direction in some cities, the practice was not widespread. Municipal regulation was a precursor to state regulation by commission, but the latter should be regarded as a major shift in the treatment of electric utilities, one that is less an evolution from municipal regulation than a reaction to its perceived failures.[27]

Two characteristics of regulation by municipal franchise would have been of particular concern to utilities. The first is the fact that the utilities were usually not granted a protected monopoly. Public sentiment favored nonexclusive franchises, and the constitutions of many states prohibited exclusive franchises.[28] Denver, for example, in 1880 granted a general electric franchise to "all comers," and free competition was not uncommon, although it did not persist. Competing utilities apparently engaged in numerous abuses, including use of the power of eminent domain to block construction by rivals or to force them to purchase property at exorbitant prices.[29] Consolidation generally led to a *de facto* monopolist in most cities, but the threat of competition from new, politically connected entrants remained.

The second worrisome characteristic of the municipal-franchise system was corruption, of which the utilities were both instigators and victims.[30] A particularly noteworthy example was that of Chicago where, on a number of occasions, a group of aldermen would grant themselves a franchise enabling them to form a utility that would compete with an existing company. The existing utility would then be given the opportunity to avoid the competition by purchasing the new franchise from the politicians. This method had been used successfully against gas and transportation utilities, but the corrupt politicians stumbled badly when they tried extortion on Samuel Insull, the new president of Chicago Edison, one of a number of small electric utilities in Chicago. In 1897 a group of aldermen known as the "gray wolves" granted themselves a 50-year franchise to provide electricity to the entire city of Chicago, preparing to play the familiar game on a new victim.[31] Insull refused to yield, and the extortionists were forced to call his bluff by actually creating an operating competitor. They soon found their

[26] Priest, "Origins."
[27] Glaeser, *Outlines*, pp. 292–99.
[28] Ibid., p. 221.
[29] Ibid., pp. 203–04; and Rose, *Cities*, pp. 21–24.
[30] Glaeser, *Outlines*, p. 232. Rich discussions can also be found in Wilcox, *Municipal Franchises*, vol. 1, pp. 101–32; and McCormick, "Discovery."
[31] This franchise, under the name Commonwealth Electric Company, extended for a substantially longer period of time than that remaining on Insull's franchise for Chicago Edison.

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way blocked by a series of agreements Insull had made with every American electrical manufacturer except Westinghouse, giving him nearly exclusive rights to purchase the equipment a utility needed to operate. Insull ultimately bought the 50-year franchise for $50,000, a fraction of the price the aldermen originally expected to get. He then used this franchise to build the first giant, integrated utility serving a large metropolitan area, under the name Commonwealth Edison.[32] Insull went on to become one of the dominant figures in the U.S. electric utility industry.

Samuel Insull became the first leader of a major, privately owned utility to publicly advocate the adoption of state regulation.[33] In his 1898 presidential address to the National Electric Light Association (NELA), the leading organization of electric utilities (and forerunner of the modern Edison Electric Institute), Insull outlined several proposals he felt would be beneficial to the industry, including the adoption of standardized equipment and the use of innovative rate structures to stimulate off-peak business and improve the load curve.[34] He ended his address by presenting his colleagues with the case for submitting to rate regulation in exchange for an exclusive franchise. That case was based primarily on the argument that such a system would improve the industry's access to capital.[35]

Beginning with a discussion of the movement for municipal ownership, Insull used a property-rights argument in favor of private enterprise that would be familiar to modern readers: "We all realize, from the close attention we have to give to our own affairs, that self-interest and the necessity of getting a return on our investment are the first essentials to the economical administration of large enterprises."[36] He argued strenuously that perceived problems in the industry were not due to bad private management: "the claim that municipal operation is the universal cure for all diseases for which electric-lighting companies are supposed to be responsible merely proposes the substitution of political in the place of industrial management." Rather, he saw the fundamental problem in the industry as competition, because "it frightens the investor, and compels corporations to pay a very high price for capital," which "must be reflected in the price paid by public and private users." His solution was to "protect" the monopoly position of

[32] McDonald, *Insull*, pp. 82–90.

[33] A year earlier, however, in a purely political maneuver, Chicago transportation magnate Charles Tyson Yerkes had tried to bribe the state legislature into passing a bill that would have extended his franchises and taken streetcar and elevated-railway regulation out of the hands of the city and vested it in a state commission. The tactic failed. Ibid., pp. 85–88.

[34] The speech is reprinted in Insull, "Standardization," pp. 34–47.

[35] Almost a quarter of a century later, in an address to the Peoria, Illinois, Association of Commerce, Insull commented, "Pioneers in the industry often had struggles that left marks upon all subsequent history of their enterprises. The public had to be educated to use public-utility service. But before there was any service to be used, investors had to be educated to furnish the money with which to build the plants and service facilities: and that was a harder task than educating the public." Insull, *Public Utilities*, p. 227. For some of his own difficulties with financing see Insull, *Memoirs*, pp. 81–87.

[36] Insull, "Standardization," pp. 42–43. Subsequent direct quotes are from pages 43–47.

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the utility whose charges would be set by public regulators "to be based on cost plus a reasonable profit." The chief benefit of protection against competition would be realized in the market for capital, not the market for electricity: "The more certain this protection is made, the lower the rate of interest and the lower the total cost of operation will be, and, consequently, the lower the price of the service to public and private users."

Insull's provocative argument has been neglected by most modern students of regulation. His argument is not predicated on the notion that electric utilities are natural monopolies, although he does say "competing companies invariably come together."[37] His major concern clearly was that competition made it difficult for private utilities to pay their bondholders and provide a return on equity to their stockholders.[38] This in turn made it difficult for utilities to raise money, thereby raising interest costs, which substantially increased the total cost of producing electricity. Competition among electric utilities, in his view, is inefficient because of the uncertainty it creates for investors. This effect was particularly strong for electric utilities because of their extreme capital intensity. His colleagues did not immediately embrace Insull's argument, although he was successful in having the NELA create a committee to investigate the issue of regulation.[39]

In addition to the federal government and the industry's major trade association, civic groups also became involved with this issue. The National Civic Federation initiated one of the most influential studies of the issue in 1905. The study was led by a group of prominent leaders, including Insull, future Supreme Court Justice Louis Brandeis, and United Mine Workers president John Mitchell. A 21-member "committee on investigation" was formed, consisting of three equally sized groups that had expressed opinions in favor of municipal ownership, in favor of private ownership, or who were considered to be neutral. The committee set out to investigate utilities both in the United States and in England, and produced a three-volume report.[40]

Much of the material in those volumes was written by individual members and reflects their individual perspectives. Although this makes the overall

[37] Progressive economists, however, relied heavily on this argument as a basis for regulation. See, for example, Adams, "Relation."

[38] As one student of the New York Public Service Commission wrote, "A modern public utility corporation is just as dependent for its existence upon the investing public as upon the consuming public. A man may be practically compelled to patronize a public service corporation which enjoys a monopolistic position, but he cannot be forced in the matter of investing his funds." The author goes on to argue that the purpose of the New York commission was to effect administrative regulation through the control of security issues. Baldwin, *Capital Control*, pp. xix, xxiii.

[39] Some executives did agree with Insull. Ernest H. Davis, a utility executive from Williamsport, PA, in a comment following a discussion of municipal ownership at the 1898 meeting, noted: "The conclusion I have arrived at individually is that investment in electric lighting plants will earn more, be better secured and more stable, if such interests are protected by a properly-regulated state commission rather than by the efforts of individual companies or by the use of statistics." *National Electric Light Association Proceedings*, p. 130.

[40] National Civic Federation, *Municipal and Private Operation*. The report received wide attention. It was summarized in Munro, "Civic Federation Report."

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report inconsistent, even contradictory, it is useful in understanding the various positions. One section, written by Charles Edgar, president of Boston Edison, and Walton Clark, vice president of the United Gas Improvement Company, reflects the views of leaders of the privately owned utilities and is particularly germane to our study. The authors were scathingly dismissive of municipal ownership and argued, as Insull did, that regulation was the proper solution: "Manager and investor must have guarantee [sic] that where they have sown they may reap."[41] They attribute the apparent financing advantage enjoyed by municipally owned utilities entirely to reduced risk: "Give a company the perpetual and exclusive franchise enjoyed by the municipality, with reasonable protection and regulation, and its bonds will sell as well as the bonds of the city for money borrowed on plant and franchise."[42]

Given its politically diverse makeup, the committee was, not surprisingly, unable to come to a conclusion on the central issue of municipal versus private ownership. Its members did, however, agree that electric utilities should be permitted to operate as monopolies, that they be required to use uniform accounting rules and to make their records public, and that privately owned utilities should be subjected to regulation of some form. One of the people who worked on the report was the noted economist John R. Commons. Commons used the recommendations of the still-unpublished study to formulate a Wisconsin law, adopted in 1907, establishing state commission regulation of electric utilities.[43] This law, with a similar one passed in New York the same year, served as a model for subsequent state commissions.[44] As the municipal-ownership movement gradually stalled, a number of prominent Progressive politicians advocated the regulation of electric utilities by state commissions, and the movement spread rapidly.[45]

The various committees of the NELA also were moving the industry to embrace state regulation. As the 1907 report of the Subcommittee on Public Regulation and Control put it, "Your committee is of the opinion that the National Electric Light Association should take the position that it is in favor of a proper system of regulation by properly-constituted authorities, provided that hand in hand with the regulation shall go proper and adequate

[41] National Civic Federation, *Municipal and Private Operation*, part 1, vol. 1, p. 426.

[42] Ibid., p. 427.

[43] In his autobiography, Commons stated, "I adopted nearly the whole of the recommendations signed by nineteen of the twenty-one members of the investigating committee of the Civic Federation." Commons, *Myself*, p. 120. He also made it clear that utility executives in the state had a say in construction of the legislation. His chief advisor on the bill creating the commission was a prominent corporate attorney. Ibid., pp. 111, 121–22.

[44] For details of the Wisconsin law see Commons, "Wisconsin Public-Utilities Law" and "How Wisconsin." On the New York law see Dearstyne, "New York Public Service Commission."

[45] Glaeser, *Outlines*, p. 234. In 1907 the Sub-Committee on Municipal Ownership of the NELA reported that the municipal-ownership movement " . . . is losing its vitality and that actual retrogression may be expected to follow." It attributed this in part to " . . . the rapidly-approaching culmination of the idea of public regulation." *National Electric Light Association Proceedings*, p. 20.

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TABLE 2
STATES WITH STRONG, WEAK, AND NO REGULATION AND DATES OF ADOPTION

States with Strong Regulation and Date	States with Weak Regulation and Date	States Not Effectively Regulated as of 1920
Massachusetts, 1889	South Carolina, 1910	Louisiana
Wisconsin, 1907	Connecticut, 1911	Kentucky
New York, 1907	Nevada, 1911	New Mexico[a]
Georgia, 1907	Washington, 1911	Delaware
Vermont, 1908	Oregon, 1911	Florida
Michigan, 1909	Rhode Island, 1912	Mississippi
Maryland, 1910	Colorado, 1913	Minnesota
New Jersey, 1910	Idaho, 1913	Iowa
California, 1911	Montana, 1913	South Dakota
New Hampshire, 1911	North Carolina, 1913	Texas
Ohio, 1911	Oklahoma, 1913	Kansas[b]
Arizona, 1912	West Virginia, 1913	Nebraska[c]
Illinois, 1913	Wyoming, 1915	
Indiana, 1913	Utah, 1917	
Missouri, 1913		
District of Columbia, 1913		
Pennsylvania, 1914		
Virginia, 1914		
Maine, 1914		
Alabama, 1915		
Tennessee, 1919		
North Dakota, 1919		
Arkansas, 1919		

[a] towns of less than 10,000 only
[b] limited regulation in towns
[c] only outside towns
Sources: Ruggles, *Aspects of the Organization, Functions, and Financing,* chs. I, IV; Mosher, *Electrical Utilities*, pp. 299–300; and correspondence with utility commissions.

protection for the capital investment in these corporations."[46] Subsequent to this report, individual utility executives occasionally opposed regulation; however, utilities and their executives were frequently in the forefront of advocacy for the establishment of state regulatory commissions.[47] By 1919 the vast majority of states had a utility commission in operation (Table 2).

The reduction of financial risk (with potentially lower interest rates) clearly was an important motivation for those electric-utility executives who

[46] *National Electric Light Association Proceedings*, p. 28. In addition, the smaller Association of Edison Illuminating Companies adopted the position at about the same time. As John W. Lieb, former president of the organization, noted several years later: " . . . we look back with gratification and pleasure on the fact that when the question of public utility regulation was first brought forward that that scheme of governmental supervision and regulation had on the floor of this convention the fullest endorsement, the fullest promise of co-operation by every member company represented in this Association. *Association of Edison Illuminating Companies Minutes*, p. 235.

[47] Anderson, *Regulatory Politics*, pp. 39–47. In California, for example, John Britton, vice-president of Pacific Gas & Electric, initiated the drive for state regulation in 1909 with a lengthy article in the state's leading financial journal. Other California utility executives " . . . led the campaign for state regulation of their firms. They hoped state regulation would end competition between their firms, enhance the value of their companies' stocks and bonds, and allow them to escape continual wrangling with county and municipal authorities." Blackford, *Politics of Business*, pp. 86–87.

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embraced state regulation. The question is: did state regulation have the intended effect? Were interest rates, and hence the costs of debt financing, actually lower in states where electric utilities were regulated? An affirmative answer would support the position of utility executives that regulation could benefit both a utility's owners and its customers.

THE IMPACT OF REGULATION ON CAPITAL COSTS

The empirical section of this article focuses first on the market for electric utility bonds in the period from 1910 to 1919 using firm-level data.[48] It was during these years that the bulk of the states adopted commission regulation of electric utilities (Table 2).[49] The second part of the empirical section uses state-level data between 1902 and 1927 to examine the relationship between regulation and output, which we interpret as a proxy for capital.

The yield to maturity on a bond is the discount rate that equates the present value of the bond's payments to its price. If a bond pays a periodic coupon rate C, and a payment at maturity of M after T periods, its present value under a discount rate r would be:

$$PV = \frac{M}{(1+r)^t} + \sum_{t=0}^{T} \frac{C}{(1+r)^t}$$

In a market in which bonds trade freely before maturity, the present value of a bond at any point in time will equal the price at which it trades. The coupon payment and payment at maturity are known. The discount rate r can then be determined from an iterative procedure that equates PV with the price of the bond. There are two components to the discount rate: $r = R_f + k$, where R_f is the risk-free rate of return and k is a risk premium which is positively associated with the probability and cost of default. If regulation reduced the risk of default by protecting the utility from competition, the risk premium k would fall, causing r to fall (assuming no change in R_f) and the market price of bonds (PV) to increase. Thus, if the advocates of state regulation of electric utilities were correct, the yield to maturity on bonds should be lower in states with regulation than in states without regulation. In addition, any risk factors specific to the utility issuing the bond or to the characteristics of the bond itself would be reflected in the yield to maturity. We can account for some of these company-specific and bond-specific risks.

[48] In 1912 funded debt represented 44 percent of total capitalization for the industry as a whole, roughly the same proportion as in 1907. U.S. Department of Commerce, *Light and Power Stations, 1912*, p. 64.

[49] Massachusetts is credited with having created the first utility-regulatory commission in 1889. Its powers at first were limited to collecting and publicizing information. Its power to control rates was gradually enhanced over the years and we consider the state to have been regulated in our model.

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Some of the bonds in the study were issued by utilities that were subsidiaries of holding companies. As discussed earlier, this was advantageous and these bonds should have a carried lower risk premium than bonds of companies not owned by a holding company. Another company-specific issue of concern during this period was the condition of electric-traction companies. In its 1920 public-utility manual, *Moody's* noted "conditions arising from the war have affected the traction companies with special severity . . . With the ending of the war it seemed that street railway operating companies would become more favorable especially as to labor. Such has not proved the case . . ."[50] In fact, during the next decade the jitney (bus) basically obliterated the street railway industry. Electric utilities that either owned or supplied a substantial proportion of their power to street railway companies should have been perceived by investors to be riskier and their borrowing costs, consequently, would have been adversely affected.

Some of the electric utilities also provided gas and water service. This might have been an advantage to a company by providing economies of scope or simply by reducing interfuel competition. On the other hand, *Moody's* was wary of utilities providing other utility services in addition to electricity in part because of the difficulty of keeping the accounts of the mixed operations separate.[51] Thus, it is uncertain whether utilities that provided more than one service had an advantage over companies that only provided electricity, so that the effect on borrowing costs also is uncertain.

Electric utilities were particularly hard-hit by the First World War and its immediate aftermath. Not only were labor markets tight and wages high, but also coal, a major input in the production of electricity, was in very short supply and became very expensive. In Chicago, for example, the price of a ton of coal went from $1.80 in 1915 to $3.45 in 1919.[52] Although some utilities managed to obtain increased rates, Samuel Insull complained that utilities were forced to get through the war mostly without raising prices[53] In fact, the real price of electricity fell during the war.[54] This should be reflected in lower bond prices and a higher risk premium in the electric-utility industry specifically due to the war and its immediate aftermath.

DATA AND MODELS

The data for the empirical investigation were taken from *Moody's Public Utility Investments* manual for the year 1920. This source of financial information contains a retrospective table containing the annual high and low prices of utility stocks and bonds for the years 1910–1919. For years in

[50] Moody, *Moody's Analyses of Investments*, 1920, p. 4.
[51] Moody, *Moody's Analyses of Investments*, 1914, p. 4.
[52] Insull, *Public Utilities in Modern Life*, p. 50.
[53] Ibid., p. 146.
[54] Edison Electric Institute, *Historical Statistics*, p. 165.

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which securities were not traded, the bid price on the last day of the year was recorded. From this table we examined every long-term, first mortgage bond with a par value of at least $1 million. In the small number of cases in which a utility had issued more than one series of first-mortgage bonds, we selected only the most recent issue. We eliminated the bonds of the small number of utilities that operated in more than one state (which would have confounded the regulation variable) as well as bonds issued by parent holding companies.[55] This resulted in the selection of 139 bonds, each issued by a different operating utility. Utilities in 38 states are represented in the data. Because some of the bonds selected were issued after 1910, and because price quotes were not available for all bonds in all years, the data comprise an unbalanced panel (pooled cross-section/time series) with 1,185 observations.[56] We recorded the following information for each bond selected: date issued, maturity date, number of years to maturity, par amount outstanding, coupon interest rate, and annual high and low price (or bid price, when the bond was not traded), and state in which the firm operated. Data on the firm issuing the bond included whether the utility was a subsidiary of a holding company, whether it provided electric traction service, and whether it was a combination gas, water, and electric utility.

The mean bond price for a year was calculated as the average of the year's high and low price (or the bid price) and was used to calculate the yield to maturity, the measure we use for r. The average yield to maturity was 5.8 percent (Table 3). To calculate the portion of r consisting of risk premium, k, we used the annual yield on long-term U.S. railroad bonds as the closest standard to the risk-free return, R_f, on bonds with a similar maturity.[57] The yield on railroad bonds was then subtracted from the calculated yield on electric-utility bonds to create an annualized risk premium, the key dependent variable in the study.[58] The average annualized risk premium was 1.2 percent (Table 3).

The critical independent variable in this model is state regulation, which we define several ways. It is not clear how long it took a regulatory commission, following its legislative creation, to become operational and have an effect. Bond markets may have reacted immediately to news of creation of a commission or may even have anticipated creation of a commission. On the other hand, given that there was little experience with this type of regulation of electric utilities, investors may have been quite uncertain about how

[55] Several of the operating companies whose bonds are represented in the sample were subsidiaries of the same holding company. Holding-company bonds were excluded from the analysis because holding companies were exempt from state regulation. We also eliminated from the sample one bond with a 100-year term.

[56] We have data over all ten years for 73 of the bonds.

[57] U.S. Department of Commerce, *Historical Statistics of the United States*, p. 1003. The rationale for using this as proxy can be found in Carty, "Regional Interest Rate Premia," p. 452. All models were also run using the unadjusted yield to maturity.

[58] The yield to maturity (or discount rate, r) was calculated using Microsoft Excel's YIELD function.

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TABLE 3
VARIABLE MEANS AND STANDARD DEVIATIONS

Variable	Mean	Standard Deviation
Regulation dummy	0.711	0.453
Regulation+3 dummy	0.508	0.500
Strong regulation+3 dummy	0.420	0.494
Weak regulation+3 dummy	0.088	0.283
Years since regulation	3.24	3.28
Average bond price	$91.18	$9.96
Yield to maturity	0.058	0.010
Risk adjusted yield to maturity	0.012	0.009
Years to maturity	24.68	10.31
Bond amount	$4.99 million	$6.30 million
Holding company dummy	0.530	0.499
Tram dummy	0.473	0.499
Combination dummy	0.552	0.497
$N = 1,185$		
Output in kwh	582,700,492	1,209,885,608
Urban population (1,000s)	890	1,374
Value added in manufacturing	$292,128,182	$584,268,025
$N = 270$		

Note: See the text for descriptions of the variables.

commissions would behave, and there may have been no impact until decisions began to be handed down. We estimate several models. We first use a variable in which regulation becomes effective in the year the commission was established, and then, following George Stigler and Claire Friedland and Gregg Jarrell, use a variable that assumes that it took three years for a commission to become operational (a qualitative variable that takes on the value one three years after state regulation was established and zero otherwise).[59] Finally, we use a variable that is the number of years since the establishment of regulation (and 0 for states with no regulation).

State regulatory commissions also varied in the specific powers they were granted by legislatures. Commissions in model states such as Wisconsin and New York were very powerful, with control over rates, accounting practices, capital expenditures, and capital structures. They had jurisdiction over all privately owned utilities in the state. Some state commissions had more limited jurisdiction, or were limited to controlling rates. A key element was whether or not they could regulate capitalization and the issuance of securities. We have used the existence of this power to split states into two groups, one of which we designate as being strongly regulated and the other as weakly regulated (Table 2). This allows us to see if the effect on borrowing costs differs due to the type of regulation.

We include year dummy variables in the model, primarily to account for the effect of World War I. Finally, state and firm dummy variables are in-

[59] Stigler and Friedland, "What Can Regulators," p. 4. Jarrell, "Demand," p. 282.

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cluded in some models to account for fixed effects not captured by the other variables.[60]

RESULTS

When state regulation was considered to have become effective in the year a commission was established, we could find no evidence that the existence of regulation had any impact on risk-adjusted yields to maturity. That is, the coefficient on the regulatory variable was not significantly different from zero and we do not report the results. When regulation was deemed to become effective three years after establishment of a commission, the results (presented in Table 4) are statistically significant. The existence of state regulation did appear to reduce the borrowing costs (risk adjusted yield to maturity) of electric utilities in those states relative to electric utilities in states without regulation.[61] The effect was confirmed when states were divided into those with strong regulation and those with weak regulation, but with the effect much more evident in states with strong regulation (after accounting for state or firm fixed effects). The magnitude of the effect on risk-adjusted yields, however, was not large, ranging from –0.16 percent to –0.22 percent per annum (a reduction of 16 to 22 basis points). This is consistent with the results for number of years since regulation, which ranges from –0.05 percent to –0.06 percent per year. Dividing the range of estimates for any regulation after three years (–16 to –22 basis points) by the mean risk adjusted yield of 1.2 percent indicates that the potential reduction in the risk component of yields in states with regulation ranged from 13 percent to 18 percent. The total bonded indebtedness of the commercial electric-utility industry in 1922 was $2.25 billion. Multiplying this figure by the range of estimates (–16 to –22 basis points) results in potential interest savings in 1922 due to regulation of between $3.6 and $4.9 million per annum. This is not a large amount of money given that total interest payments by commercial electric utilities in 1922 amounted to $126 million.[62]

Neither the holding company nor the combination dummy is strongly significant. There is weak evidence that combination utilities had to pay a slight premium, but contrary to *Moody's* expectation, holding companies did not appear to reduce the borrowing costs of their operating utilities by lowering the risk premium. The *Tram* dummy clearly supports *Moody's* position on the perilous condition of electric tramways. Its coefficient is always positive, statistically significant, and large in magnitude compared to other dummy variables. Of the bond-specific variables, *Years to Maturity* was statistically significant in only one case, indicating a flat yield curve.

[60] We estimate the model in Stata, using White heteroscedastic-consistent standard errors.

[61] Consistent results were found when using the unadjusted yield to maturity as the dependent variable.

[62] United States Department of Commerce, *Light and Power Stations, 1922*, pp. 116, 130.

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TABLE 4
REGRESSION RESULTS FOR BONDS
(dependent variable is risk adjusted yield to maturity)

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Regulation+3	–0.00154*	–0.00223*	–0.00156*					
	(0.014)	(0.002)	(0.002)					
Years since regulation							–0.00063*	–0.00053*
							(0.005)	(0.003)
Strong regulation+3				–0.00132*	–0.00240*	–0.00171*		
				(0.045)	(0.003)	(0.002)		
Weak regulation+3				–0.00283*	–0.00168	–0.00054		
				(0.005)	(0.184)	(0.597)		
Years to maturity	–0.00003	–0.00002	–0.00005	–0.00003	–0.00002	–0.00043*	–0.00003	–0.00011
	(0.263)	(0.389)	(0.453)	(0.244)	(0.382)	(0.000)	(0.255)	(0.168)
Holding company dummy	0.00077	0.00030	–0.00100	0.00071	0.00029	–0.00362*	–0.00003	–0.00059
	(0.166)	(0.617)	(0.364)	(0.196)	(0.634)	(0.001)	(0.959)	(0.675)
Tram dummy	0.00349*	0.00171*		0.00356*	0.00171*		0.00174*	
	(0.000)	(0.007)		(0.000)	(0.007)		(0.004)	
Amount	–0.00012*	–0.00013*		–0.00013*	–0.00013*		–0.00013*	
	(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	
Combination dummy	0.00057	0.00106		0.00054	0.00106		0.00088	
	(0.311)	(0.056)		(0.338)	(0.056)		(0.096)	
1910 dummy	–0.00081	–0.00069	0.00024	–0.00087	–0.00069	0.00175*	–0.00125	–0.00006
	(0.478)	(0.456)	(0.702)	(0.447)	(0.454)	(0.007)	(0.209)	(0.943)
1911 dummy	–0.00131	–0.00147	–0.00076	–0.00137	–0.00147	0.00038	–0.00186*	–0.00099
	(0.201)	(0.076)	(0.187)	(0.183)	(0.076)	(0.517)	(0.037)	(0.169)
1912 dummy	–0.00134	–0.00169*	–0.00132*	–0.00141	–0.00169*	–0.00061	–0.00182*	–0.00137*
	(0.150)	(0.024)	(0.007)	(0.132)	(0.024)	(0.214)	(0.023)	(0.015)
1913 dummy	–0.00153	–0.00174*	–0.00154*	–0.00158	–0.00174*	–0.00116*	–0.00170*	–0.00151*
	(0.099)	(0.017)	(0.000)	(0.088)	(0.018)	(0.008)	(0.027)	(0.001)

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TABLE 4 — continued

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
1915 dummy	–0.00156	–0.00164*	–0.00167*	–0.00156	–0.00164*	–0.00200*	–0.00119	–0.00134*
	(0.120)	(0.035)	(0.000)	(0.117)	(0.035)	(0.000)	(0.137)	(0.004)
1916 dummy	–0.00209*	–0.00230*	–0.00222*	–0.00202*	–0.00232*	–0.00299*	–0.00180*	–0.00187*
	(0.027)	(0.004)	(0.000)	(0.032)	(0.004)	(0.000)	(0.031)	(0.002)
1917 dummy	0.00008	0.00019	0.00006	0.00011	0.00019	–0.00107	0.00091	0.00060
	(0.943)	(0.847)	(0.928)	(0.921)	(0.849)	(0.072)	(0.393)	(0.472)
1918 dummy	0.00195	0.00187	0.00188*	0.0020	0.00187	0.00035	0.00308*	0.00275*
	(0.095)	(0.076)	(0.006)	(0.090)	(0.076)	(0.598)	(0.012)	(0.008)
1919 dummy	0.00440*	0.00445*	0.00437*	0.00443*	0.00445*	0.00251*	0.00621*	0.00566*
	(0.0001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.005)	(0.000)	(0.000)
State dummies		Included**			Included**		Included**	
Firm dummies			Included**			Included**		Included**
Constant	0.01158*	0.01300*	0.01170*	0.01166*	0.01305*	0.02962*	0.01205*	0.01584*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.097	0.368	0.738	0.100	0.368	0.741	0.362	0.731

* indicates statistical significance at the 5-percent level

** indicates jointly significant at the 5-percent level.

Notes: $N = 1{,}185$; p-values are in parentheses.

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Amount (the size of the bond) was negative and statistically significant. Because the costs of marketing bonds had fixed elements, some economies apparently were realized from larger issues. The effect of the war on borrowing costs was evident, especially for 1919; the coefficient for that year is positive, statistically significant, and quite large in magnitude. State dummy variables were jointly statistically significant, as were the firm-specific dummy variables.

STRONG VERSUS WEAK REGULATION AND OTHER REGULATION-INDUCED EFFECTS

The empirical measure of regulation's effect on the interest rate may underestimate the total effect. Another factor affecting the level of risk premium faced by any firm would be its total debt. A firm with a large debt would have to experience faster growth in future revenue than a firm with a smaller debt to be able to service and repay that debt. In the absence of such growth the firm might have to default, although it could also enjoy higher profits were such revenue growth to occur. The necessity for more rapid growth makes the firm's future more risky. For any single firm, a larger debt would thus require a higher interest rate. This suggests that each firm may face something akin to an individual supply curve for total debt: the larger the total debt incurred by any one firm, the higher the interest rate that firm may face. If this is the case then the reduction in risk brought about by regulation would have an effect similar to a downward shift in the supply curve. The amount that equilibrium price (interest rate) decreased would depend on the shape of the firm's demand curve and would be related to the amount by which total debt increased. In this case our estimate of the effect of regulation on the interest rate would measure the change in the equilibrium interest rate, which would be less than the downward shift in the firm's supply curve of debt.

Unfortunately, the data contained in *Moody's* are not sufficient to analyze the financial structure of the utilities with bonds in this sample. However, we looked at a related issue: did regulation lead to increased production of electricity? Because increased production came primarily through an increase in capital investment, this may be viewed as a reasonable proxy for increased investment, including bonded indebtedness.

Data on total output aggregated by state are available from the quinquennial *Census of Electric Light and Power Stations*. We used data for the years 1902 through 1927. Explanatory variables (also from Census sources) included urban population (because centrally generated electricity was almost exclusively urban in this period) and value added in manufacturing.[63]

[63] The observations for these explanatory variables were taken in the same or prior years as the observations for electricity output. Hence, for example, urban population in 1900 was used to explain total output in both 1902 and 1907.

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Various fixed-effects models were used in which state dummy variables were always included. The models differed in whether year dummies and year interactions with urban population and value added in manufacturing were included. Strong and weak regulation were included as dummy variables (equal to one, three years after the onset of regulation) and as integers measuring the number of years since the onset of regulation. The results, for the key regulation variables only, are summarized in Table 5.

The results are similar for all of the models. Weak regulation had a positive effect on output that was statistically significant at the 5-percent level in every case but one. Its magnitude ranged from 3.5 percent to 25 percent of the average output of all observations. The estimated effect of strong regulation was also positive, but its magnitude was somewhat smaller and it was not statistically significant. This is the opposite of the result found in the models explaining the risk premium, where strong regulation generally had more of an effect than weak regulation. One interpretation of this is that the presence of strong regulation affected the firm's demand curve for debt. This seems reasonable because strong regulation required the firm to obtain regulatory approval before issuing new debt (or other instruments). To the extent such regulation restrained the firm from increasing debt, it may also have hindered growth in output. Yet the lower effective quantity of debt would have been consistent with a greater impact of regulation on the reduction of the equilibrium risk premium, as we found.

CONCLUSION

The historical record of the process that culminated in state regulation of electric utilities suggests that reduced borrowing costs was a primary reason utility companies, with prominent leaders such as Samuel Insull leading the way, came to embrace regulation. It was argued that the utilities' customers also would benefit from regulation if the lower borrowing costs led to increased investment and output, and hence lower prices.[64] Our analysis suggests that regulation did reduce borrowing costs, but that the magnitude of the effect was small. Furthermore, regulation apparently led to increased output, perhaps as a result of increased investment and indebtedness. In states with strong regulation, however, commissions may have restrained utilities from incurring as much debt as they otherwise would have. In these states, the improved access to capital markets was reflected more strongly in a reduced risk premium.

There are other factors not included in this analysis that might have caused us to underestimate the true benefit of regulation. Investors may have expected the move to state regulation to eventually encompass more states.

[64] Emmons, "Franklin D. Roosevelt," using firm-level data, estimated a model showing that electric utility rates in 1930 were from 4.0 percent to 6.4 percent higher in states without regulation than in states with regulation. This is consistent with our results.

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TABLE 5
REGRESSION RESULTS ON STATE-LEVEL TOTAL ELECTRICITY OUTPUT

Model	Variable	Estimated Coefficient	Asymptotic t Value	p Value	R^2
Regulation measured as dummy=1 three years after onset of regulation					
Year dummies included; Year interactions with urban population and manufacturing value added included	Strong Regulation	5.41e+07	0.84	0.402	0.9545
	Weak Regulation*	1.56e+08*	2.16*	0.032*	
Year dummies included; Year interactions with urban population only included	Strong Regulation	7.93e+07	1.17	0.242	0.9534
	Weak Regulation*	1.71e+08*	2.34*	0.020*	
Year dummies excluded; Year interactions with urban population and manufacturing value added included	Strong Regulation	5.54e+07	1.09	0.276	0.9535
	Weak Regulation	1.42e+08	1.90	0.058	
Year dummies excluded; Year interactions with urban population only included	Strong Regulation	7.22e+07	1.34	0.182	0.9524
	Weak Regulation*	1.47e+08*	1.99*	0.048*	
Regulation measured as number of years since onset of regulation					
Year dummies included; Year interactions with urban population and manufacturing value added included	Strong Regulation	2.73e+06	0.26	0.792	0.9555
	Weak Regulation*	2.20e+07*	2.46*	0.015*	
Year dummies included; Year interactions with urban population only included	Strong Regulation	4.25e+06	0.44	0.660	0.9543
	Weak Regulation*	2.29e+07*	2.68*	0.008*	
Year dummies excluded; Year interactions with urban population and manufacturing value added included	Strong Regulation	1.15e+06	0.18	0.856	0.9548
	Weak Regulation*	2.00e+07*	2.53*	0.012*	
Year dummies excluded; Year interactions with urban population only included	Strong Regulation	1.92e+06	0.29	0.770	0.9536
	Weak Regulation*	2.03e+07*	2.60*	0.010*	

* indicates the variable is statistically significant at the 5-percent level.

Notes: Estimations were done in Stata, using White heteroscedastic-consistent standard errors.

Sources: U.S. Department of Commerce, *Census of Electric Light and Power Stations*, 1912, table 30, p. 50; 1922, table 56, p. 94; 1927, table 29, pp. 43–44. U.S. Department of Commerce, Bureau of the Census, *Thirteenth Census*, 1910, Vol. VIII, Manufactures, table III, pp. 542–44; *Fourteenth Census*, 1920, Vol. II, Population, table 20, pp. 79–87, Vol. VIII, Manufactures, table 48, pp. 171–73; *Fifteenth Census, Manufactures 1929*, Vol. III, table 4, pp. 17–20.

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By anticipating that a state would become regulated, investors may have reduced the perceived risk of bonds issued by utilities in that state. Thus regulation may have reduced borrowing costs for utilities in a state even before that state became regulated, a result that would have reduced the impact of regulation as measured here. The modest magnitude of our key estimated coefficient suggests that regulation may not have been *essential* for the continued viability and expansion of the privately owned electric utility industry in the United States. On the other hand regulation may have helped create an environment in which the availability of electricity could dramatically increase, as, indeed, happened in the 1920s, contributing to the nation's economic growth.

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