Ownership, Technology, and the Provision of Residential Electricity *

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Abstract

Economists have long been interested in the implications of private versus public ownership for the provision of services and consumer prices. Empirically, the challenge is to disentangle the effect of ownership from other determinants of prices. In this paper, we use detailed data on retail electricity in the United States to identify the effect of private versus public ownership on prices. Our data include information on thousands of markets, which allow us to control for observed differences in demand and cost conditions. At typical consumption levels, we find that differences between public and private rates were negligible. This suggests the gains from changing ownership type were small in 1935. However, as new technology reduced minimum efficient scale and incentivized private entry into smaller markets, we show that markets switched from public to private ownership. We interpret these findings as evidence for the benefits of maintaining organizational or contractual flexibility and increasing the prospect of passing gains from technological progress on to consumers.

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1 Introduction

In the United States, the majority of utility services (e.g., for water, gas, and electricity) are provided by private enterprises. Still, in some instances, local governments intervene to substitute public for private ownership. For example, although investor-owned utilities accounted for over two thirds of electricity sales in 2012, publicly-owned firms substantially outnumbered privately-owned firms. The current pattern of ownership is the result of conditions that jump-started the industry's expansion in the late nineteenth and early twentieth centuries. As access to electricity services increased, communities chose the ownership form (i.e. public or private) taking into account local demand, cost, and political considerations. Today, the evidence suggests these decisions had long-lasting effects. For example, Davis and Wolfram (2012) and Hausman (2014) find that private utilities in the United States tend to be more efficient and have better safety records. In India, Alcott, Collard-Wexler, and O'Donnell (2014) show that non-market allocation methods used by public utilities may lead to shortages that reduce manufacturing productivity.

In this paper, we develop a new data set to test for the impact of ownership structure on prices in the context of new technology adoption in the early electricity industry. Our data include information for all electrified communities in the United States in 1935. The historical setting allows us to incorporate information on proximity to the transmission grid, a key determinant of ownership structure in this time period. In addition, detailed information on the location of utilities allows us to control for demand, cost, and regulatory variables commonly used to explain the prevailing pattern of ownership.

As communities across the United States electrified in the early twentieth century, local officials faced the decision of whether to provide electricity through public ownership or sign a contract with a private utility. Several theories propose explanations for the choice of ownership. Public interest theories emphasize the role of market failure stemming from natural monopoly, externalities, or financing constraints (Pigou, 1932). Most relevant for the observed differences in ownership type in the early electricity industry is the small size of local markets (Marston, 1916; Schap, 1986). In our context, these theories would suggest that demand was small relative to the cost of contracting with private firms.

Alternatively, contracting theories emphasize the threat from opportunistic politicians

(Alchian, 1965; Goldberg, 1976; Williamson, 1985; Levy and Spiller, 1994; Troesken, 1997; Troesken and Geddes, 2003). Contract failure arises in a political environment where, for example, bribes or pressure to reduce rates may damage the value of the firm's specific, non-redeployable capital. Thus, these theories would suggest that when political costs are high, local officials elect to organize and provide utility services through public ownership.

There is large literature that aims to quantify the impact of the ownership decision on prices and efficiency. Peltzman (1971) finds higher prices under private ownership, which he attributes to price discrimination, and notes that public ownership may create incentives to set rates that maximize reelection potential rather than profits. Meyer (1975), Neuberg (1977), Färe, Grosskopf, and Logan (1985), and Atkinson and Halvorsen (1986) provide cost estimates that indicate private and public ownership are equally efficient. Closer to the period we study in this paper, Hausman and Neufeld (1991) and Emmons (1993, 1997) show that public utilities may be more efficient in the absence of substantial regulation, while (Hausman and Neufeld, 2002) show that efficiency is similar for public and private firms following the introduction of state level utility regulation. Many of these studies were limited to a small number of potentially selected markets or aggregated across many markets so that the impact of ownership and regulation are confounded.

In this paper, we study how improvements in the transmission technology affected the "make or buy" decision in the provision of residential electricity services. Local officials first had to decide whether to provide service or not and then whether to contract with a private utility or organize a publicly-owned utility. For the empirical analysis, we draw on data that provide the most comprehensive view of residential electricity prices during the industry's early development. In this way we are able to control for differences in demand and cost conditions as well as some features of the regulatory and political environment. We then examine the determinants of ownership, focusing on the role of proximity to the transmission grid, and test for the impact of ownership on prices.

First, we find that private utilities tended to serve smaller markets that are concentrated near grid infrastructure. This suggests that improvements in transmission reduced the minimum efficient scale required to enter relatively small markets. At the same time, transmission reduced the local capital investment required to served politically costly locations, thus less capital was exposed to damage by opportunistic politicians. Second, at typical household consumption levels, we find that differences between public and private rates were small (or zero). In the context of constraints stemming from the industry's natural monopoly characteristics, our results suggest the potential gains from changing ownership type were small in 1935. However, as expansion of the transmission grid reduced the minimum efficient scale and incentivized private entry into smaller markets, we find that markets switched from public to private ownership. Our findings suggest there may be considerable benefits from maintaining flexibility in contractual and organizational choice.

2 The Early Electricity Industry and Expansion of Transmission

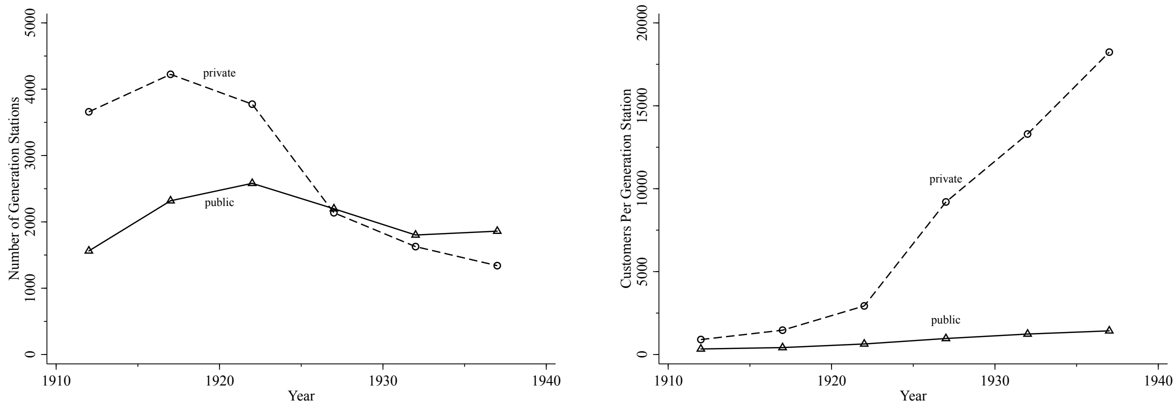
The retail electric light industry was created in 1881 with the lighting of J.P. Morgan's home and the completion of Thomas Edison's Pearl Street Station in the following year. The Pearl Street station generated direct current electricity at a central plant in New York City, which was then distributed to homes and businesses near the plant. At first, delivery was limited to homes within approximately one mile of the central station. However, between 1881 and 1900 the number of central service station increased from 8 to over 3,000.

Soon after the formation of the Edison-Morgan partnership, a former Edison engineer Nikola Tesla, backed by George Westinghouse, developed the polyphase alternating current motor. Alternating current, due to its higher voltage, enabled delivery over much longer distances. Competition between direct and alternating current continued throughout the 1880s. In 1893, Westinghouse was awarded contracts to supply the Chicago World's Fair and setup generators on Niagara Falls to supply electricity to Buffalo. This cemented alternating current as the industry standard.

In subsequent decades, investment and revenues for the industry as a whole increased dramatically: roughly fifty-fold in each case (US Census Bureau, 1932). This was accompanied by substantial churning as the number of utilities fluctuated first increasing and with privately-owned utilities outnumbering publicly-owned utilities. By 1927, the number of utilities by ownership type were approximately equal and over the next decade private ownership declined so that public ownership was the majority type.

Churning in the industry was also characterized by switching from public to private

Figure 1: Establishments and Customers Per Establishment by Ownership, 1912-1937



A. Number of Establishments B. Customers Per Establishment

Source: For 1912 to 1922, data on the number of establishments stations and customers are from US Census Bureau (1922, Table 5 and Table 6). For 1927 and 1932, data are from US Census Bureau (1932, Table 5). For 1937, data are from US Census Bureau (1937, Table 12 and Table 13).

ownership and merging of privately-owned utilities. Indeed, the consolidation of privately-owned generation capacity is responsible for much of the decline in Figure 1A and was the result of changes in technology throughout the 1920s. For example, in 1922 California's Pacific Gas and Electric constructed the first 220 kilovolt transmission line from Pit River in the Sierra-Nevada Mountains to connect the San Francisco Bay Area. The increase in voltage from 110 to 220 kilovolts allowed a fourfold increase in power to the city, and this was transmitted over 200 miles with minimal load losses (*Pacific Service Magazine*, 1922, p. 345). Innovations such as these led to consolidations and buyouts in the late 1920s and 1930s (Schap, 1986).[1]

Contemporary accounts highlight the role high voltage transmission lines played in determining the ownership of electricity utilities.

> The new technology of the electric light and power industry, embodied principally in the system of large-scale, centralized production of electricity, with broadened market reached by high tension long-distance transmission lines and with interconnection of these central supply stations, appears to have been the most

[1] In 1935, the Public Utility Holding Company Act was passed requiring interstate utility holding companies to be geographically contiguous. Large holding companies were successfully divested after 1946, following the *North American Company v. Securities and Exchange Commission*. However, these divestitures did not lead to substantial change in ownership at the local level.

> important condition affecting the character and extent of municipal ownership of electric establishments. (Dorau, 1930)

Between 1900 and 1925, the National Electric Light Association reported reasons why roughly 800 publicly-owned utilities opted to sell their generation plants and distribution equipment to private utilities outright or purchase their electricity requirements from other systems (National Electric Light Association, 1925, pp. 87-227). Of these, 623 are included in our data for 1935 and their proximity to the transmission grid highlights the grid's role in determining ownership. The average distance to the grid for utilities that switched from public to private ownership during the 1910s and 1920s was 64 percent closer than utilities that remained public until the mid-1930s.

For specific evidence, take the case of Wytheville, Virginia, located between the two major cities in the region: Roanoke, Virginia, and Charleston, West Virginia.

> About 1905 the town of Wytheville built a small municipal plant, but after operating it a very short time leased it to a corporation, which, in turn, about 1911 sold the plant to the Appalachian Power Company, which was building a transmission system and hydro-development in the vicinity, so that the service is now supplied by that company (National Electric Light Association, 1925, pp. 207).

This and other stories suggest proximity to the grid was central in determining the ownership type of utilities.

From the point of view of utilities, there were several reasons for expanding the grid. First, there was increasing demand from large cities. Second, interconnection provided more reliable service. Self-contained systems, particularly those dominated by hydroelectric power (e.g., in California, the Southeast, and the Pacific Northwest), were highly susceptible to drought. Third, interconnection insured against natural disasters and other causes of damaged lines. Finally, interconnection reduced the capital requirements to satisfy local demand: locations with excess supply were able to transmit their power to those with excess demand.

The growth of the electricity industry in the first half of the twentieth century makes clear the relationship between the ownership decision and technology. Given market characteristics, cost and political structure, and expectations of future demand, a municipality had to decide whether to generate and distribute its own electricity or contract for service with private firms. As the technology changed over this period, incentives for public provision were eroded and communities switched to private provision.

The historical record, emphasizes the role of the development of an interconnected grid and technology that allowed power to be transmitted over large distances. Interconnection was driven by two key factors, the desire to unlock the potential of hydroelectric generation to supply large cities and to connect major markets to one another. Sources of hydroelectric power were determined by geography and the expansion of the grid during this period was based on connecting historically large population centers. In our empirical analysis, we control for distance to the grid so that comparisons are between markets with similar access to technology and we drop the largest cities from our sample to focus on areas where connection to the grid was incidental. In addition, we control for other variables that reflect demand and cost conditions. Finally, since our sample period precedes the introduction of several New Deal reforms (e.g., Tennessee Valley Authority, Rural Electrification Administration, Public Utility Holding Company Act, and Bonneville Power Administration), we avoid the empirical challenges that arise in this environment.

3 Data

3.1 Sources and Variables

The data used in the empirical analysis are at the market-level for all electrified communities in the United States with a population of at least 250 in 1935. These data are from the Federal Power Commission's *Electric Rate Survey* and were part of the first effort to record residential electricity prices for the entire country (Federal Power Commission, 1935a). The survey includes the name of the market, whether electricity is provided publicly or privately, population, minimum bill, number of hours in the minimum bill, and typical bills at different levels of consumption (in terms of kilowatt hours). These data were estimated at the time of publication to cover 99 percent of all kilowatt hours generated in the United States (Federal Power Commission, 1935a, p. 2) and give a comprehensive view of residential electricity prices during this period. This is key to addressing problems in previous work that rely on more aggregated data or smaller samples of selected markets.[2]

The data do not contain information on marginal prices (i.e., the rate schedule) for each utility. Instead, we use the typical bill at different usage levels to construct the corresponding average price at those usages. For example, Edison Electric & Illuminating Company serving the community of Acton, Massachusetts, charged \$18.3 for a monthly usage 15 kilowatt hours, which translated to an average price per kilowatt hour of \$1.2; for a monthly usage of 25 kilowatt hours the bill was \$28.7, which gives a price of \$1.1 per kilowatt hour. Formally, the measure of average price (per kilowatt hour) used in the empirical analysis is:

$$P_i^\ell = \frac{\text{average bill for market } i \text{ at usage } \ell}{\ell \text{ kilowatt hours}}$$

From a regulatory perspective, recent evidence suggests that average price is more salient than marginal price (Ito, 2014) and, therefore, the more relevant policy variable.[3] Using average prices allows us to make comparisons between prices charged by different utilities for the same level of consumption. We are also able to quantify the effect of ownership on the price per kilowatt hour throughout the rate schedule. Figure 2 shows how the average price variable we use relates to the marginal price (based on the rate schedule) set by a hypothetical utility.

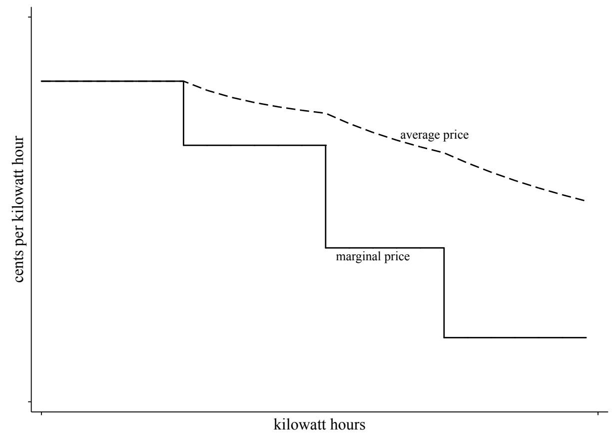
We merge the data from the *Electric Rate Survey* with information on the exact location of each market from the National Atlas of the United States (2004). The transmission grid, which includes high voltage lines and central generation plants as reported by the Federal Power Commission, were geocoded in ArcGIS and the corresponding digitized map is shown in Figure 3. From this information, we calculate the distance of each city or town to the transmission grid and the nearest generation station in 1935.

To control for variation in demand and cost conditions at the county-level we use information from Haines (2010) on urban population, homes with electricity, retail sales per capita, total manufacturing value-added, and employment in farms, retail, wholesale, and

[2]The authors of the report underlying our data recognized potential for errors, for example, due to the complexity of the rate schedule and additional fees. However, there is no evidence to suggest omissions were different for public and private utilities and, therefore, do not bias our results.

[3]Ito (2014) attributes this behavioral response to the information costs of (i) understanding the nonlinear rate schedule and (ii) tracking cumulative monthly consumption.

Figure 2: Marginal and Average Price for Hypothetical Utility



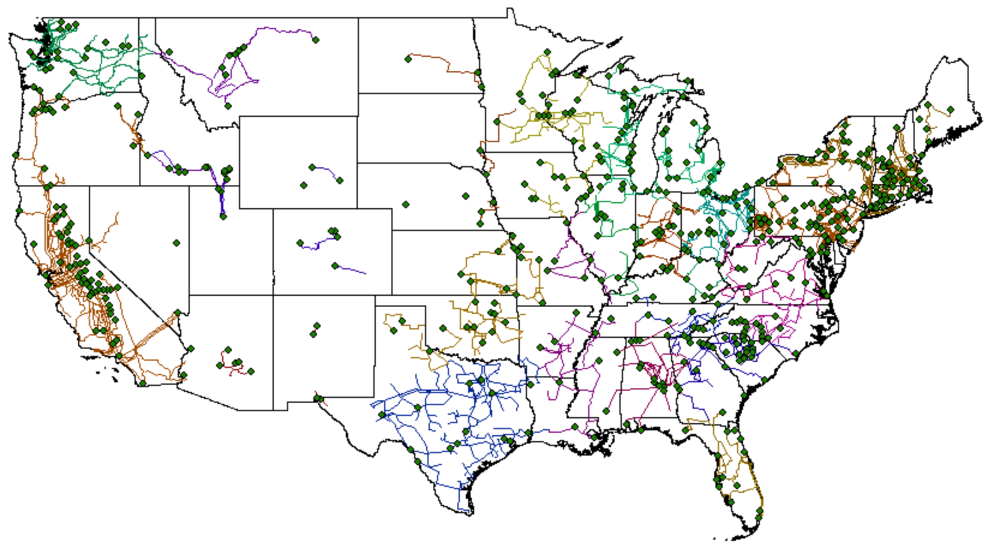
manufacturing; from Fishback, Kantor, and Wallis (2003) we use the average democratic vote share between 1896 and 1928 for a measure of local political preferences, which may influence local demand for public provision of utility services. Finally, we construct an indicator variable equal to one if the rates of private utilities are regulated in a given state and zero otherwise (Federal Power Commission, 1935c). This variable captures regulation at the *state* level, but not additional regulation enacted at the local level.

3.2 Sample Construction

For our empirical analysis we impose minimal restrictions on the sample. We start with the 17,739 unique markets reported in the Federal Power Commission survey for the contiguous United States. We merge these data with the National Atlas of the United States' *Cities and Towns of the United States* index. After dropping observations with missing data, we are left with 14,714 observations. We restrict the sample to places with population less than 100,000 to focus on communities that were not large enough to attract construction of high voltage transmission lines, influence regulation, or influence prices in input markets. Thus, we focus on markets where access to technology embodied in the transmission grid or other market conditions are a byproduct of their proximity to large cities.[4] In the end, we are left with 14,632 markets including 32.2 percent of the US population. In robustness checks presented below we examine the sensitivity of our results to the choice of the 100,000

[4]One illustration is the example of Wytheville, Virginia, given in Section 2, which located between the larger cities of Roanoke, Virginia, and Charleston, West Virginia.

Figure 3: Transmission Grid, 1935



Source: The map was digitized from Federal Power Commission (1935b).

population threshold.

Table 1 provides summary statistics for the characteristics of markets nationwide (column 1) as well as all markets in our sample (columns 2 through 5). Column 2 includes markets with population less than 100,000, columns 3 and 4 present summary statistics for private and public utilities, respectively, and column 5 gives the difference between markets under the two ownership structures. Markets in our sample have 2,624 residents on average compared to 4,364 nationwide. Comparing columns 1 and 2, the differences across all variables are small, except population (which is by design).

Within our sample, columns 3 through 5 make clear that there are some differences in terms of the characteristics of markets served by private and public utilities. For market-level characteristics (Panel A), markets served by public utilities are larger in size and farther from the transmission grid. From Panel B, private utilities serve markets in counties with a larger share of homes with electricity service and living in an urban area, a larger share employed in retail and manufacturing, a smaller share employed in farming, and higher value-added by manufacturing. Finally, from Panel C, private utilities are more often located in states

Table 1: Summary Statistics

	All Markets:	Sample Markets (≤ 100K pop.):			
	Combined	Combined	Private	Public	Difference
	(1)	(2)	(3)	(4)	(5)
A. market-level					
Miles to Transmission Grid	16.202	16.280	15.563	22.597	-7.034
Population, 1935 (thousands)	4.699	2.779	2.689	3.571	-0.882
B. county-level					
Share Homes w/ Electricity, 1929	0.590	0.587	0.588	0.573	0.015
Urban Share, 1929	0.324	0.321	0.325	0.290	0.034
Avg. Demoractic Vote Share, 1896-1928	0.444	0.444	0.444	0.444	0.000
Retail Sales Per Capita, 1929 (hundreds)	3.324	3.313	3.310	3.335	-0.024
Retail Emp. Share, 1929	0.023	0.023	0.023	0.022	0.000
Wholesale Emp. Share, 1929	0.006	0.006	0.006	0.006	0.000
Mfg. Emp. Share, 1929	0.046	0.046	0.047	0.039	0.008
Farm Emp. Share, 1929	0.387	0.389	0.383	0.438	-0.055
Mfg. Value-Added, 1929 (millions)	40.520	39.455	41.342	22.820	18.522
C. state-level					
State Regulates Private Utility	0.750	0.750	0.759	0.669	0.090
Observations	14,714	14,632	13,182	1,450	14,632

Notes: Column 1 presents summary statistics for all town and cities in Federal Power Commission (1935a); column 2 drops markets with population 100,000 or more; columns 3 and 4 show summary statistics for private and public, respectively; column 5 is the difference between columns 3 and 4 (statistically significant at 1 percent level in bold).
Source: Miles from the transmission grid is authors' calculation based on Federal Power Commission (1935b). Population is from Federal Power Commission (1935a). The regulation indicator is from Federal Power Commission (1935c). The remaining variables are from Haines (2010) and Fishback, Kantor, and Wallis (2003).

that regulate rates at the state-level.

4 Empirical Framework

The summary statistics make clear that public and private utilities operate in different markets. Without correcting for differences in markets served by ownership type, our estimate of the price difference between public and private utilities will potentially be biased. To enforce comparisons between public and private utilities that serve similar markets we use propensity score matching (Rosenbaum and Rubin, 1983); to predict the probability of private ownership we use observed characteristics of markets that reflect variation in demand, cost, and regulation. The variables used to construct the propensity score for private ownership are listed in Table 1. We predict the equilibrium ownership structure in each market using the following specification:

$$O_i = f(d_i) + \mathrm{M}_i + \mathbf{X}_i\beta + \mathrm{R}_s + \varepsilon_i \tag{1}$$

In equation (1), O_i is an indicator equal to one if market i is served by a private utility and zero otherwise. $f(d_i)$ is a function of market i's distance to the transmission grid and M_i is the population of i. In practice, we use a set of indicator variables for distance $d \in (1\text{-}5, 6\text{-}10, \ldots, 50+)$, to approximate the function $f(\cdot)$. $\mathbf{X}_i$ is the vector of county-level characteristics and R_s is an indicator for state s regulates private rates. In some specifications, we replace R_s with state dummy variables, θ_s.[5] We assume that ε_i is normally distributed so that equation (1) can be estimated using a probit regression.

To recover the effect of ownership structure on (log) average price in market i at usage level ℓ, we follow Abadie and Imbens (2006) and use nearest-neighbor matching to estimate the average treatment on the treated.

$$\begin{array}{l}\text{treatment on treated} \\ \text{at consumption } \ell \ (\tau^\ell)\end{array} = \frac{1}{N_O}\sum_{i=1}^{N_1} O_i\left(\log P_i^\ell - \frac{1}{M}\sum_{j\in J_M(i)} \log P_j^\ell\right) \tag{2}$$

where N_O is the number of markets served by privately-owned utilities, M is the number of matches for each observation, and $J_M(i)$ is the set of nearest-neighbors matches to i.[6] We correct standard errors for the fact that the propensity score is estimated (Abadie and Imbens, 2011, 2012).

Importantly, ownership decisions are made by profit-maximizing firms and, therefore, not randomly assigned.[7] Instead, identification of the ownership effect depends on controlling for characteristics that reflect demand and cost conditions. At the market level, distance to the grid controls for access to transmission technology and population for differences in demand at the extensive margin. At the county level, the share of homes with electricity, urban

[5] State dummy variables are co-linear with the indicator used to capture the *state* regulatory environment. Therefore, in specifications that include state dummy variables we omit the regulation indicator.

[6] For our main results we use the closest neighbor to estimate (2). We also report results using the five nearest neighbors and use the approach described in Hirano, Imbens, and Ridder (2003) to reweight each observation by the propensity score. These alternatives give qualitatively similar results.

[7] Chandra and Collard-Wexler (2009) use propensity score matching to study the impact of (endogenous) merger decisions on prices in the Canadian newspaper industry.

share, retail sales per capita, manufacturing value-added, and share employed in the retail, wholesale, manufacturing, and farm sectors, capture variation in demand at the intensive margin. The average democratic vote share captures local preferences for the local provision of infrastructure. In each case, we use values of these variables prior to 1935. At the state level, we control for whether a particular state regulated private rates in 1935.

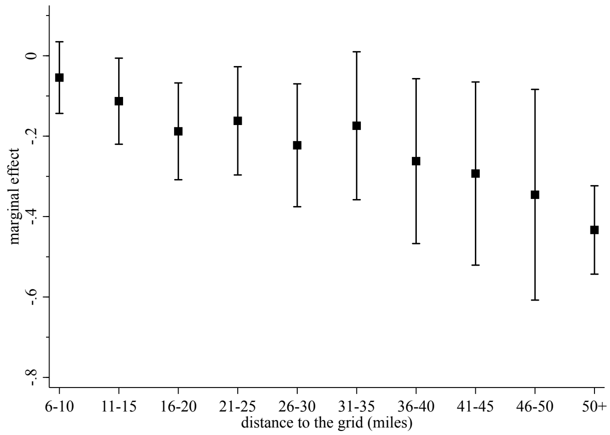
The identification assumption is conditional mean independence for equation (2). In our setting this means the expected effect of ownership on average price (at a given usage) depends only on observed factors. Two details are important to note. First, by excluding larger markets we avoid violations of the identification assumption that arise, for example, because ownership structure influences the regulatory environment. Second, we control for the most important source of demand-side variation in prices (e.g., market size, sectoral composition) as well as controlling for the role of technology in determining ownership (i.e., distance to the grid). The potential for remaining unobservables to bias our estimates is further limited by inclusion of state dummy variables.

In terms of the main theories for the determinants and consequences of private versus public ownership, the focus in this paper is on public and group interest theories. From our empirical analysis, private utilities charging lower prices over the entire range of monthly usage would provide evidence for public interest. That is, under public interest, the focus of local politicians is simply providing access to electricity and possibly subsidizing smaller users. On the other hand, group interest theory (e.g., Peltzman, 1971) predicts that local officials aim to collect votes from important constituencies by extracting less of the consumer surplus. Thus, at typical usage levels, public utilities set prices closer to competitive for the largest bloc of voters and the public-private difference is absent or small. For larger usages, public utilities charge higher prices to extract rents from less important voting blocs and private utilities lower prices in the face of more elastic demand.

5 Results

We discuss our results in three parts: (i) in Section 5.1, we show the results for the determinants of ownership structure and diagnostics related to constructing the propensity score, (ii) in Section 5.2 we present our results for the impact of ownership type on residential electricity prices, and (iii) Section 5.3 tests robustness.

Figure 4: Distance to Transmission Grid and Private Ownership



Notes: This figure plots marginal effects for each 5-mile increment relative to "1-5" miles from grid (the excluded dummy variable) based on estimates of equation (1). The estimate of the marginal effects ±2 standard errors are shown in "brackets."

Source: Author's calculation based on estimates from equation (1). See Section 5.1.

5.1 What determines ownership structure?

The results from estimating equation (1) are shown separately for distance to the transmission grid (Figure 4) and the remaining market-, county-, and state-level variables in Table 2. Figure 4 plots the marginal effects for each 5-mile increment relative to "1-5" miles from grid (the excluded dummy variable). It is clear that as distance to the grid increases, the probability of private ownership decreases. For example, a market that is 11-15 miles from the grid is 25 percent less likely to be served by a private utility. Our interpretation is, first, that access to grid technology lowered minimum of efficient scale for entry by private firms and thus loosened constraints on ownership due to the industry's natural monopoly characteristics. Second, by taking control for key infrastructure improvements away from local politicians, their ability to exploit the specific, non-redeployable features of this investment was limited.

In Table 2 we present the marginal effects for other determinants of ownership based on estimating equation (1). The dummy variables controlling for distance to the grid are included in all columns. Column 1 includes only market size, M_i; column 2 adds the county- and state-level characteristics, $\mathbf{X}_i$ and R_s, respectively; and column 3 replaces the indicator for state regulation of private rates with a set of state dummy variables, θ_s. In each column, the probability of private ownership decreases with the size of the market measured by population, the share of electrified homes, and the urban share. Some features of the composition of the local economy are also an important determinant of ownership. In columns 2 and 3 of Table 2, higher retail sales per capita, lower share employed on farms, and higher manufacturing value-added, predict a higher probability of private ownership.

An important contribution of this study is to control for a state's regulatory environment and separately examine the role of the ownership decision in residential electricity prices. Column 2 of Table 2, Panel C shows that the marginal effect of switching to state regulation is to increase the probability of private ownership by 15.5 percentage points. While there are more private utilities in regulated states, these utilities' ability to influence regulation is limited by the fact that they serve individual markets within the state.[8] We caution against a strictly causal or structural interpretation of the results in Table 2.

Before moving to our results for the impact of ownership on prices, we present a few diagnostic tests in favor of our identification strategy based on propensity scoring matching. First, Figure A1 in Appendix A shows the frequency distribution for the number of markets served by private and public utilities at different ranges of the propensity score; the figure indicates significant overlap in the distributions. Second, the sample is well-balanced in the sense that after using the propensity score to find the nearest neighbor or reweighting observations using the propensity score, typical measures of bias decrease.[9]

5.2 Residential electricity prices and ownership structure

Our results for the effect ownership on prices are summarized in Figure 5. In each panel, usage ℓ is on the x-axis and the estimate of the average treatment on the treated is on the y-axis. Panel A shows the results for the differences in average price between private and public utilities controlling only for the distance to the grid and and market population. The results show that at monthly usages between 15 and 40 kilowatt hours, the rate of private utilities exceed those of public utilities; for monthly usages greater than 100 kilowatt hours,

[8]In many instances, the utilities serving individual towns or cities are connected through a common holding company. In this paper, we are primarily interested in the effect of private versus public ownership on prices.

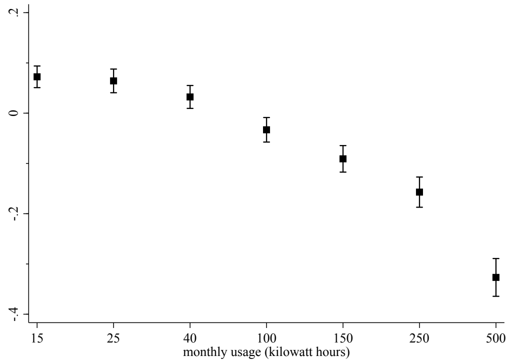
[9]For example, our different specifications for the propensity score reduce measures of standardized bias by roughly two thirds (see Rosenbaum and Rubin, 1985).

Table 2: Probit Regression for Determinants of Private Ownership

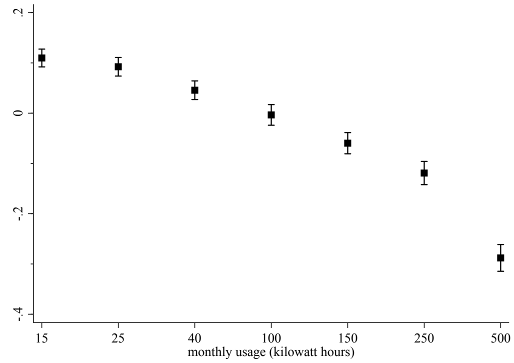
	(1)	(2)	(3)
A. market-level			
Population, 1935 (thousands)	-0.0106	-0.0128	-0.0142
	(0.0016)	(0.0017)	(0.0018)
B. county-level			
Share Homes w/ Electricity, 1929		-0.2304	-0.2327
		(0.0622)	(0.0611)
Urban Share, 1929		-0.3083	-0.1966
		(0.1358)	(0.1518)
Avg. Demoractic Vote Share, 1896-1928		0.0715	-0.4559
		(0.1069)	(0.2159)
Retail Sales Per Capita, 1929 (hundreds)		-0.0679	-0.1479
		(0.0326)	(0.0408)
Retail Emp. Share, 1929		-0.2106	13.0431
		(4.7919)	(5.5044)
Wholesale Emp. Share, 1929		-1.3528	-2.1465
		(3.0181)	(3.0045)
Farm Emp. Share, 1929		-1.3713	-0.8226
		(0.1504)	(0.1819)
Mfg. Emp. Share, 1929		-0.4904	-0.0253
		(0.4701)	(0.5510)
Mfg. Value-Added, 1929 (millions)		0.0005	0.0003
		(0.0001)	(0.0001)
C. state-level			
State Regulates Private Utility		0.1280	
		(0.0358)	
Distance to Grid	Yes	Yes	Yes
State Dummy Variables	No	No	Yes

Notes: This table shows the marginal effect based on estimating equation (1). The dependent variable is the indicator, O_i, which equals 1 for private ownership and 0 otherwise. Panels A, B, and C show results for market-, county-, and state-level variables, respectively. All columns include dummy variables for distance to the transmission grid in 5-mile increments. In addition, column 1 also includes population in 1935; column 2 adds all county-level and state-level characteristics; column 3 replaces the indicator for state regulation of private rates with a set of state dummy variables. Standard errors are in parentheses.
Source: See Section 3 and Table 1.

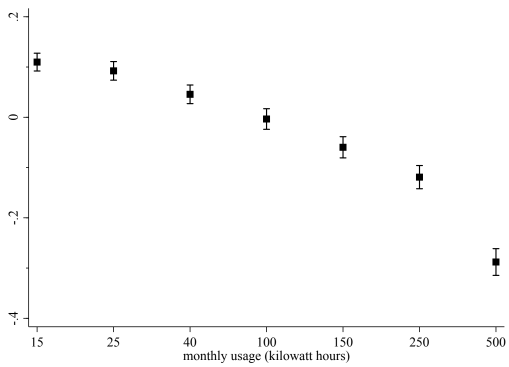
Figure 5: Price Effect of Private versus Public Ownership



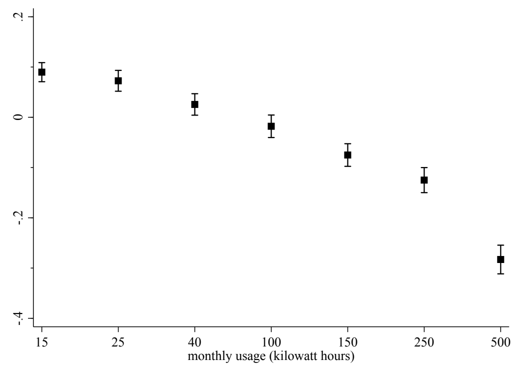
A. Controls: $f(d_i), \mathrm{M}_i$



B. Controls: $f(d_i), \mathrm{M}_i, \mathbf{X}_i$



C. Controls: $f(d_i), \mathrm{M}_i, \mathbf{X}_i, \mathrm{R}_s$



D. Controls: $f(d_i), \mathrm{M}_i, \mathbf{X}_i, \theta_s$

Notes: The figure shows estimates from different specifications of equation (2). The dependent variable is $\log P_i^{\ell}$. Panel A shows the percent difference between private and public utilities controlling for market-level characteristics, panels B and C add county- and state-level characteristics, respectively; Panel D replaces the state regulation indicator with state dummy variables. The estimates for the private-public difference at each usage *ell* ± 2 standard errors are shown in "brackets."
Source: See Section 3 and Table 1.

private rates are lower. Panel B adds county-level controls, X_i, to the propensity score; Panel C adds the indicators for state regulation; and Panel D replaces the state regulation variables with a set of state dummy variables.

Moving from Panel A to Panel D, the distribution of estimated price differences between private and public utilities shifts upwards, which suggests that failure to control for market selection may lead to biased estimates. Our preferred specification is in Panel D and these results show that for low usages (i.e., between 15 and 40 kilowatt hours) the private per kilowatt hour prices are between 4.6 to 11.0 percent higher than public rates. At 100 kilowatt hours per month, the private-public difference is statistically indistinguishable from zero and for higher monthly usages private rates are between 6.0 and 28.8 percent lower than public rates. If our empirical strategy controls for demand conditions as well as the portion of cost attributable to differences in transmission technology, our results suggest that private utilities had lower costs. Indeed, there is evidence that private utilities invested more hydroelectric and steam generation, which contributed to higer economies of scale.[10] Given the different incentives faced by private and public utilities, this suggests lower generation costs for private utilities.

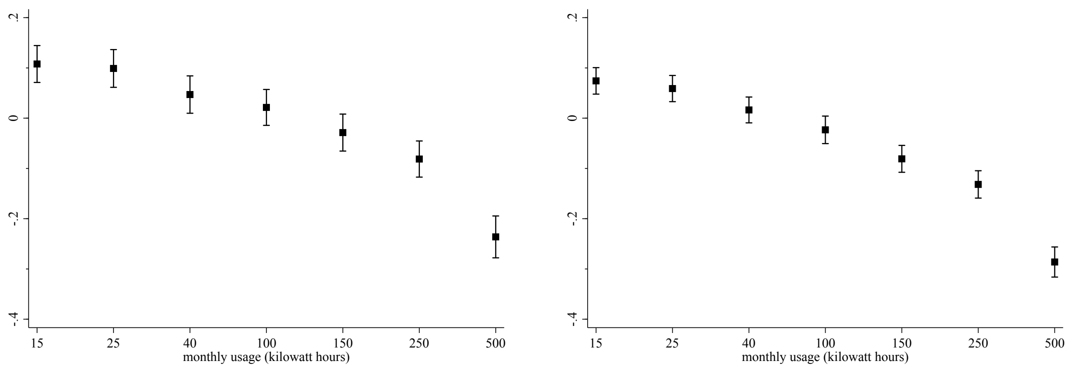
These results reflect the combined effect of markets in regulated and unregulated states. As discussed earlier and in the literature, rates in regulated and unregulated markets may differ because of the incentives faced by state and local officials. In Figure 6 we present separate estimates for the private-public difference in regulated and unregulated states.[11] The results in the two panels of Figure 6 are qualitatively similar. This is reassuring and suggests controlling for a set of state dummy variables helps to eliminate state-level differences that are confounded with the effect of ownership in previous studies.

At this point it is useful to highlight key features of our results. First, we show that the private-public difference per kilowatt hour varies with monthly consumption. This is essential for understanding how private and public utilities exploit non-linearities in the rate schedule. Previous studies have focused on aggregate (e.g., state-level) costs or average prices at a single usage and this has contributed to different conclusions about the explanation and efficacy of public versus private ownership. Second, information on the location and ownership type in each market allowed us to control for local demand and cost conditions. Indeed, the results for the ownership decision in Section 5.1 provide evidence for selection, which may bias the estimates of the private-public difference. Finally, we control directly for the state regulatory environment.

[10] In the 1920s, the *Census of Electric Light and Power Plants* reported that private utilities generated 2.7 times more electricity per employee than publicly-owned firms private utilities and used half as much coal-equivalents per kilowatt hour generated. By 1932, the average generation cost for private utilities was 26 cents per kilowatt hour and sometimes as low as 9 cents in hydroelectric facilities, compared with 51 cents per kilowatt hour for public utilities (US Census Bureau, 1927, 1932).

[11] The unregulated states include Colorado, Delaware, Florida, Iowa, Kansas, Michigan, Minnesota, Mississippi, South Dakota, and Texas.

Figure 6: Price Effect of Private versus Public Ownership by Regulatory Status



A. Unregulated B. Regulated

Notes: The figure shows estimates of equation (2) by regulatory status. The dependent variable is $\log P_i^{\ell}$. Panel A shows the results for states that do not regulate privates rates and Panel B shows the results for states that do regulate private rates. The specifications include the following covariates: $f(d_i), \mathrm{M}_i, \mathbf{X}_i$, and θ_s. The estimates for the private-public difference at each usage *ell* ± 2 standard errors are shown in "brackets."
Source: See Section 3 and Table 1.

5.3 Robustness

In Table 3, we examine the robustness of our main results to changes in the population cutoffs that determine our sample size, changes in utility policy during the New Deal, the specification of $f(d_i)$, the presence of additional generation infrastructure, and alternative matching methods. The first row reproduces our main result from Panel D of Figure 5 for the effect private versus public ownership on the average price per kilowatt hour.

In the rows 2 through 5, we test the sensitivity of our results to using population cutoffs of 50,000, 10,000, 5,000, and 1,000. This is to ensure that our initial assumption that markets with population below 100,000 did not influence the construction electricity infrastructure (e.g., transmission lines, generation stations) is not overly strong. Indeed, the historical narrative suggests that focus of infrastructure expansion was to integrate the largest markets with each other and hydroelectric generation facilities. For the first three alternative cutoffs, the results similarly suggest that private rates were higher from 15 to 40 kilowatt hours per month. For markets with less than 1,000 population, the number of observations is reduced and the private-public difference below 40 monthly kilowatt hours disappears. For all markets the effect for 40 kilowatt hours per month and above are qualitatively similar.

Table 3: Robustness for Price Effect of Private versus Public Ownership

	Monthly Usage (ℓ):						
	15 kwh	25 kwh	40 kwh	100 kwh	150 kwh	250 kwh	500 kwh
1: Main Result	0.1098	0.0924	0.0457	-0.0034	-0.0597	-0.1191	-0.2880
	(0.0089)	(0.0092)	(0.0093)	(0.0103)	(0.0105)	(0.0116)	(0.0133)
2: Sample: less 50K pop.	0.0989	0.0874	0.0449	-0.0057	-0.0637	-0.1284	-0.2983
	(0.0095)	(0.0097)	(0.0095)	(0.0099)	(0.0103)	(0.0113)	(0.0127)
3: Sample: less 10K pop.	0.0781	0.0619	0.0203	-0.0439	-0.1043	-0.1634	-0.3310
	(0.0120)	(0.0131)	(0.0142)	(0.0157)	(0.0173)	(0.0189)	(0.0245)
4: Sample: less 5K pop.	0.0523	0.0316	-0.0075	-0.0804	-0.1457	-0.2238	-0.4071
	(0.0132)	(0.0134)	(0.0120)	(0.0115)	(0.0127)	(0.0139)	(0.0168)
5: Sample: less 1K pop.	0.0048	-0.0072	-0.0441	-0.1408	-0.2177	-0.3120	-0.5067
	(0.0161)	(0.0185)	(0.0180)	(0.0189)	(0.0213)	(0.0223)	(0.0286)
6: Sample: no TVA states	0.1139	0.0954	0.0550	-0.0057	-0.0648	-0.1271	-0.2991
	(0.0095)	(0.0096)	(0.0096)	(0.0100)	(0.0106)	(0.0114)	(0.0133)
7: Distance is 4^{th}-order poly.	0.0996	0.0865	0.0434	-0.0069	-0.0657	-0.1215	-0.2872
	(0.0112)	(0.0120)	(0.0119)	(0.0108)	(0.0111)	(0.0116)	(0.0131)
8: Add distance to gen. station	0.1010	0.0821	0.0347	-0.0151	-0.0720	-0.1267	-0.2954
	(0.0095)	(0.0105)	(0.0106)	(0.0115)	(0.0123)	(0.0130)	(0.0144)
9: Use five nearest-neighbors	0.0987	0.0828	0.0390	-0.0159	-0.0742	-0.1320	-0.3029
	(0.0084)	(0.0084)	(0.0080)	(0.0081)	(0.0085)	(0.0094)	(0.0109)
10: Use inverse prob. weighting	0.0966	0.0811	0.0373	-0.0154	-0.0736	-0.1293	-0.2988
	(0.0075)	(0.0078)	(0.0077)	(0.0078)	(0.0083)	(0.0089)	(0.0104)

Notes: This table presents the main result from Figure 5D (row 1) and several robustness checks (rows 2 through 10). The dependent variable is $\log P_i^\ell$. Row 1 includes all market- and county-level characteristics as well as state dummy variables. Rows 2 through 5 restrict the sample to be less than different population thresholds. Row 6 drops states included in the TVA service region. Row 7 replaces the dummy variables used to approximate $f(d_i)$ with a fourth-order polynomial in distance. Row 8 adds distance (in miles) to nearest generation station. Row 9 uses the five nearest neighbors when estimating equation (2) and row 10 uses inverse probability weighting. Standard errors are in parentheses.
Source: See Section 3 and Table 1.

During the 1930s, the New Deal brought several policy changes in electricity markets including the Tennessee Valley Authority, Rural Electrification Administration, Bonneville Power Administration, and passage of the Public Utility Holding Company Act. Many of these projects did not begin until after our sample period: the Rural Electrification Administration was established in 1935 and the Bonneville Power Administration in 1937. The Public Utility Holding Company Act was passed in 1935, but not upheld in the courts until 1943. As a result, we focus on the potential impact of electrification under the Tennessee Valley Authority (TVA). The TVA was created in 1933 and prior to passage of the key legislation there was concern that private utilities in the region were preemptively cutting their rates. Although Kitchens (2014) finds little support for this claim, row 6 of Table 3 shows the results of dropping markets in the states included in the TVA's service area (i.e., Alabama, Mississippi, and Tennessee). The differences between these and our main results are small.

Rows 7 and 8 of Table 3 test the robustness of our results to the functional of $f(d_i)$ as well as adding distance to the nearest generation station. In row 9, we use the five nearest neighbors to construct the estimate of the average treatment on the treated in equation (2) and, in row 10, we use inverse probability weighting (as in Hirano, Imbens, and Ridder, 2003). In each case the results are similar to those in row 1, suggesting our results are robust to changes in sample and specification.[12]

6 Interpretation

So far we have shown that private firms supplied electricity at higher prices for small quantities and at lower prices for larger quantities. Our primary interest is understanding whether ownership had an impact on the prices faced by the average residential consumer as well as the relative importance of public or group interest theories in explaining provision and price of these services. Based on our own tabulations from the *Study of Consumer Purchases in the United States, 1935-1936* (US Department of Labor, 2009) as well as contemporary coverage (*New York Times*), the best evidence suggests that typical consumption was between 40 and 100 kilowatt hours per month.[13] In light of these consumption data, our results suggest that the observed ownership structure in 1935 had little impact on the prices faced by residential consumers.

To interpret this result, we start with the decision of local officials to provide electricity through public ownership or to sign a contract with a private utility. The variation in ownership decisions across markets is determined by the differences in demand, cost, and regulation. The role of the transmission grid was to reduce the costs for private entry relative

[12] Our main results are for 1935 because this predates key changes in the regulatory and wholesale environment for electricity (e.g., Tennessee Valley Authority, Public Utility Holding Company Act, and Rural Electrification Administration). However, to address concern that depressed demand in the middle of the 1930s genearated a different pricing structure between public and private utilities, we also repeated our analysis using data from 1940 (reported in Appendix Table A1). Excluding the TVA region, which experienced rapid change over the 1930s, these estimates are comparable to results presented in Table 3.

[13] Estimates from the 1935-36 Consumer Expenditure Survey (CES) are based on sample of urban households. Comparing additional information from the CES on expenditures with monthly bills reported in our data suggests that these usages are reasonable.

to the costs of constructing and maintaining a system under public ownership. On the margin, our results suggest there was no price difference between publicly- versus privately-owned utilities at typical monthly usages. To the extent that public and private utilities faced similar conidtions, these results indicate little total effect on monthly bills.

Of course, it is common to assume objectives differ under public or private ownership. Indeed, the change in the estimated private-public difference over the range of monthly usages (i.e., between 25 and 500 kilowatt hours) in Figure 5D suggest differences consistent with Peltzman (1971). Specifically, Peltzman (1971) analyzes the incentives faced under public and private ownership, noting that officials in charge of public utilities are also vote maximizing. These officials have an incentive to keep prices low for their largest constituencies, so the rate schedule is flat over the the distribution of monthly consumption (i.e., no quantity discounts). In contrast, under private ownership, profit-maximizing utilities price discriminate and this shows up in our estimates as higher rates at low quantities and lower rates at high quantities.

By itself the relationship between on ownership and prices is only suggestive evidence for the role of technology, specifically the transmission grid. For additional evidence, we draw on information for the markets that changed from public to private provision between 1935 and 1940.[14] These "switchers" were closer on average–12.8 versus 24.2 for "stayers"–and their rates decreased by more–7.4 to 12.8 for 40 and 100 monthly kilowatt hours, relatively–over the same period. Thus, proximity to the grid shaped the constraints on private entry due to the industry's natural monopoly characteristics and as these were loosened, private ownership was substituted for public ownership.

7 Conclusion

Innovation that allowed electricity utilities to centrally generate and transmit power over larger distances led to substantial changes in access to electricity during the 1920s and 1930s. Improved transmission technology provided customers with all-day service, while interconnection reduced the risk of outages and allowed utilities to smooth peak-load demand

[14] The observations on markets that switched from public to private ownership is 44 between 1935 and 1940. The data for 1940 are drawn from the *Typical Electric Bills* published by the Federal Power Commission (1940).

across space. Furthermore, proximity to the transmission grid reduced the risk that industry-specific, non-redeployable capital would be expropriated or damaged by local politicians. Over time, these factors combined to make smaller markets increasingly attractive for private utilities.

In the 1930s, private utilities sought to integrate their generators with the largest markets. In this setting, we study the relationship between electricity prices and ownership (i.e., public versus private). Although there is a large literature that examines the impact of ownership type on the provision, efficiency, and pricing of utility services, previous studies utilize data that cannot distinguish the effect of ownership from underlying demand, cost, and regulatory conditions. In this paper, we use comprehensive data on all electrified communities in 1935 to contribute to this literature. In our empirical analysis, we use propensity score matching to address the selection of utilities by ownership type into particular markets. Specifically, we enforce comparisons between similar markets in terms of proximity to the transmission grid as well as market-, county-, and state-level characteristics.

In our preferred specification, which restricts comparisons to markets with similar characteristics and located in the same state, we find that prices for private utilities were higher at low levels of consumption and lower at high levels of consumption. This highlights the importance of observing data over a large range of consumption when firms use nonlinear price schedules. Most importantly, at typical household consumption levels, the difference between public and private rates were negligible. In the context of the constraints stemming from the industry's natural monopoly characteristics, our results suggest the potential gains from changing ownership type were small in 1935.

However, as technological change reduced the minimum efficient scale needed for private utilities to enter smaller markets, we find evidence that markets switched from public to private ownership. Specifically, improvements in generation and transmission reduced capital requirements. Since these communities were free to provide their own service or contract for it, they were able to translate these technological improvements into lower residential electricity prices. Today, this may no longer be the case. For example, under the Tennessee Valley Authority, local distributors must either be publicly-owned or organized as a cooperative and are required to have wholesale contracts with TVA. Without the organizational or contractual flexibility that prevailed in the period we study, technological gains that lower costs for wholesalers may not be passed on to consumers.

References

Alberto Abadie and Guido W. Imbens. Large Sample Properties of Matching Estimators for Average Treatment Effects. *Econometrica*, 74(1):235–267, 2006.

Alberto Abadie and Guido W. Imbens. Bias-Corrected Matching Estimators for Average Treatment Effects. *Journal of Business & Economic Statistics*, 29(1):1–11, 2011.

Alberto Abadie and Guido W. Imbens. Matching on the Estimated Propensity Score. Working Paper, 2012.

Armen Alchian. Some Economics of Property Rights. *II Politico*, 30(4):816–829, 1965.

Hunt Alcott, Allan Collard-Wexler, and Stephen O'Donnell. How Do Electricity Shortages Affect Productivity? Evidence from India. NBER Working Paper 19977, 2014.

Scott Atkinson and Robert Halvorsen. The Relative Efficiency of Public and Private Firms in a Regulated Environment: The Case of US Electric Utilities. *Journal of Public Economics*, 29(3):281–294, 1986.

Ambarish Chandra and Allan Collard-Wexler. Mergers in Two-Sided Markets: An Application to the Canadian Newspaper Industry. *Journal of Economic and Management Strategy*, 18(4):1045–1070, 2009.

Lucas W. Davis and Catherine Wolfram. Deregulation, Consolidation, and Efficiency: Evidence from US Nuclear Power. *American Economic Journal: Applied Economics*, 4(4): 194–225, 2012.

Herbert B. Dorau. *The Changing Character and Extent of Municipal Ownership in the Electric Light and Power Industry*. The Institute for Research in Land Economics and Public Utilties, 1930.

William M. Emmons. Franklin D. Roosevelt, Electric Utilities, and the Power of Competition. *Journal of Economic History*, 53(4):880–907, 1993.

William M. Emmons. Implications of Ownership, Regulation, and Market Structure for Performance: Evidence from the US Electricity Utility Industry Before and After the New Deal. *Review of Economics and Statistics*, 79(2):279–289, 1997.

Rolf Färe, Shawna Grosskopf, and James Logan. The Relative Performance of Publicly-Owned and Privately-Owned Electric Utilities. *Journal of Public Economics*, 26(1):89–106, 1985.

Federal Power Commission. *Electric Rate Survey*. Government Printing Office, Washington, DC, 1935a.

Federal Power Commission. *National Power Survey Interim Report, Power Series No. 1*. Government Printing Office, Washington, DC, 1935b.

Federal Power Commission. *Electric Rate Survey: State Commission Jurisdiction and Regulation of Electric Rates and Service. Rate Series No. 6*. Government Printing Office, Washington, DC, 1935c.

Federal Power Commission. *Typical Electric Bills*. Government Printing Office, Washington, DC, 1940.

Price V. Fishback, Shawn Kantor, and John J. Wallis. Can the New Deal's Three R's Be Rehabilitated? A Program-by-Program, County-by-County Analysis. *Explorations in Economic History*, 40(3):278–307, 2003.

Victor Goldberg. Regulation and Administered Contracts. *Bell Journal of Economics*, 7(2): 426–452, 1976.

Michael R. Haines. *Historical, Demographic, Economic, and Social Data: The united States, 1790-2000*, volume ICPSR02896-v3. Inter-university Consortium for Political and Social Research [distributor], Ann Arbor, MI, 2010.

Catherine Hausman. Corporate Incentives and Nuclear Safety. *American Economic Journal: Economic Policy*, 6(3):178–206, 2014.

William J. Hausman and John L. Neufeld. Property Rights Versus Public Spirit: Ownership and Efficiency of U.S. Electric Utilities Prior to Rate-of-Return Regulation. *Review of Economics and Statistics*, 73(3):414–423, 1991.

William J. Hausman and John L. Neufeld. The Market for Capital and the Origins of State Regulation of Electric Utilities in the United States. *Journal of Economic History*, 62(4): 1050–1073, 2002.

Keisuke Hirano, Guido W. Imbens, and Geert Ridder. Efficient Estimation of Average Treatment Effects using the Estimated Propensity Score. *Econometrica*, 71(4):1161–1189, 2003.

Koichiro Ito. Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing. *American Economic Review*, 104(2):537–563, 2014.

Carl Kitchens. The Role of Publicly Provided Electricity in Economic Development: The Experience of the Tennessee Valley Authority, 19291955. *Journal of Economic History*, 74 (2):389–419, 2014.

Brian Levy and Pablo T. Spiller. The Institutional Foundations of Regulatory Commitment: A Comparative Analysis of Telecommunications Regulation. *Journal of Law, Economics, and Organization*, 10(2):201–246, 1994.

Glenn Marston. Shortcomings of Municipal Plants. *National Electric Light Association Bulletin*, 3(10):821–823, 1916.

Robert A. Meyer. Publicly Owned versus Privately Owned Utilities: A Policy Choice. *Review of Economics and Statistics*, 57(4):391–399, 1975.

National Atlas of the United States. Cities and Towns of the United States, 2004. URL `http://nationalatlas.gov/`.

National Electric Light Association. *Political Ownership and Electric Light and Power Industry*. National Electric Light Association, New York, 1925.

Leland G. Neuberg. Two Issues in the Municipal Ownership of Electric Power Distribution Systems. *Bell Journal of Economics*, 8(1):303–323, 1977.

New York Times. Electric Rates Cut 76 Times in 3 Years, year = April 19, 1926. page 32.

Pacific Service Magazine. Leading Features of Achievemnt By Which "Pacific Service," During the Past Year, Aided Materially in the Development and Prosperity of the Territory Covered By Its Operations. 14:343–347, June 1922.

Sam Peltzman. Pricing in Public and Private Enterprises: Electric Utilities in the United States. *Journal of Law and Economics*, 14(1):109–147, 1971.

Arthur Cecil Pigou. *The Economics of Welfare*. Macmillan and Co., London, 1932.

Paul R. Rosenbaum and Donald B. Rubin. The Central Role of the Propensity Score in

Observational Studies for Causal Effects. *Biometrika*, 70(1):41–55, 1983.

Paul R. Rosenbaum and Donald B. Rubin. Constructing a Control Group Using Multivariate Matched Sampling Methods That Incorporate the Propensity Score. *The American Statistician*, 39(1):33–38, 1985.

David Schap. *Municipal Ownership in the Electric Utility Industry*. Praeger Publishers, 1986.

Werner Troesken. The Sources of Public Ownership: Historical Evidence from the Gas Industry. *Journal of Law, Economics, and Organization*, 13(1):1–25, 1997.

Werner Troesken and Rick Geddes. Municipalizing American Waterworks, 1897-1915. *Journal of Law, Economics, and Organization*, 19(2):373–400, 2003.

US Census Bureau. *Census of Electrical Industries: Central Electric Light and Power Stations*. Government Printing Office, Washington, DC, 1922.

US Census Bureau. *Census of Electric Light and Power Plants*. Government Printing Office, Washington, DC, 1927.

US Census Bureau. *Census of Electrical Industries: Central Electric Light and Power Stations*. Government Printing Office, Washington, DC, 1932.

US Census Bureau. *Census of Electrical Industries: Central Electric Light and Power Stations*. Government Printing Office, Washington, DC, 1937.

US Department of Labor. *Study of Consumer Purchases in the United States, 1935-1936*, volume ICPSR08908-v3. Inter-university Consortium for Political and Social Research [distributor], Ann Arbor, MI, 2009.

Oliver E. Williamson. *The Economic Institutions of Capitalism*. Free Press, New York, 1985.

A Additional Figures & Tables

Figure A1: Histogram for Propensity Score of Private versus Public Observations

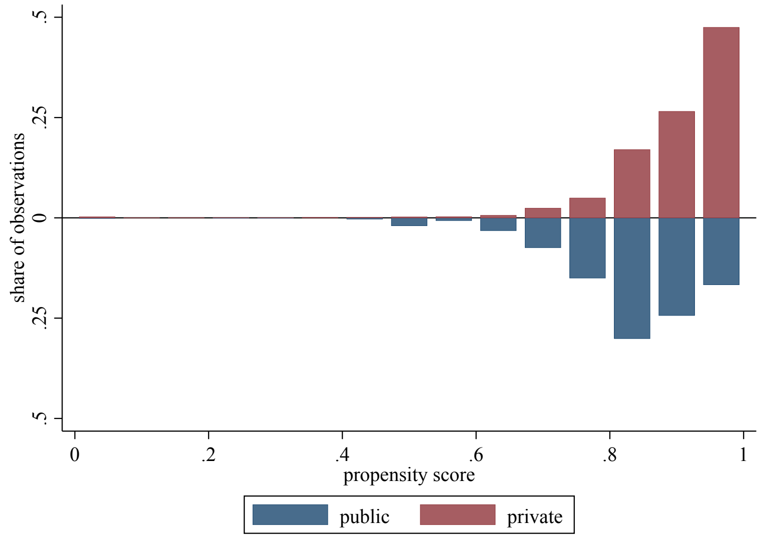


Table A1: Robustness for Price Effect of Private versus Public Ownership with 1940 Data

	Monthly Usage (ℓ):					
	15 kwh	25 kwh	40 kwh	100 kwh	250 kwh	500 kwh
Sample: 1940 data	0.0407	0.0136	0.0074	0.0006	-0.0462	-0.2005
	(0.0094)	(0.0105)	(0.0103)	(0.0085)	(0.0090)	(0.0113)

Notes: This table presents results using data from 1940 and excluding the TVA region. The dependent variable is $\log P_i^\ell$. Standard errors are in parentheses.
Source: See Section 3 and Table 1.