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Assets, Service Areas, and Market Power

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Compatible Mergers: Assets, Service Areas, and Market Power*

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Abstract

We empirically examine the discrepancy between the incentive of firms to merge and the social value of mergers using data on merger waves in the pre-WWII Japanese electricity industry when a competition authority did not yet exist. We find that firms could enjoy cost synergies when merging with firms with greater differences in production asset composition and/or reachable customers. Such "compatible" mergers resulted in increases in capital utilization and output. However, these synergies did not affect the merger decision; instead, geographical proximity increased the likelihood of mergers. These results imply that the merger incentive may not align with social welfare.

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Keywords: Mergers and Acquisitions, Merger Policy, Merger Waves.

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1 Introduction

Economists in various fields, including financial economics, industrial organization, and macroeconomics, have intensively studied why firms merge and how mergers affect the economic value of firms and social welfare. However, although considerable attention has been given to merger determinants and post-merger outcomes in the existing literature separately, investigating them *together* is important as a means to design an appropriate merger regulation policy. This is because mergers and acquisitions (M&As) are important sources of change in market structure and, depending on the aim of the firms involved, e.g., market power or cost efficiency, mergers may have different consequences. However, the market mechanism does not necessarily induce "compatible mergers," i.e., mergers that create synergies as a joint entity, because firm incentives to merge may not necessarily align with improvements in social welfare. This paper bridges these two strands of the literature by identifying the merger patterns that contribute to improving social welfare and whether it is possible for private firm incentives to attain these appropriate patterns. This enables us to better design merger policies, including competition and bailout takeover policy.

To advance our understanding of mergers, we create a novel dataset from the merger waves in the Japanese electricity industry in the early 20th century. A number of advantages flow from the study of mergers in this particular industry and period. First, during this period, there was no antitrust authority. In general, the study of mergers suffers from a selection issue due to the regulatory approval process of antitrust agencies. We then only observe a selected sample of mergers where parties considered that the probability of antitrust approval was sufficiently high in the data, which may be more socially suitable. Ignoring this endogeneity may result in biased estimates for the determinants and the effects of mergers. Our dataset is free from such concerns. Second, a large number of mergers took place in the given industry. One of the major limitations of existing studies is that mergers do not occur very frequently within a given industry, and this usually restricts the framework for analysis. Finally, very detailed plant- and firm-level data are available. During the period in question, all electricity utility firms reported plant-level production activity and firm-level assets, equipment, cost and revenue to the Japanese government, and the government published these micro data in a statistical handbook every year. Combined, these advantages allow us to implement the analysis.

The electricity industry consists of generation, transmission, distribution, and sale of electric power to final users. This vertical industry structure enables us to identify some potential determinants of mergers: “tangible asset” composition, “intangible asset” composition and geographical proximity. We define tangible asset composition as the composition of power generation capacity and transmission/distribution facilities, which represents the firm’s strength within the vertical structure of the industry. Tangible asset composition determines the allocative efficiency in the use of factor inputs—generation capacity and transmission/distribution facilities—in electricity supply. We define intangible asset composition as the fraction of retail customers (household) to business customers (wholesale), which represents the firm’s strength in horizontal competition in the downstream market. In the period of our study, the households demanded electricity mostly during the nighttime, whereas the business customers demanded electricity mostly during the daytime. Thus, intangible asset composition is a key factor to determine operation efficiency by smoothing electricity demand over the day. Finally, as pointed out in many other studies, we believe that geographical proximity is an important determinant of mergers, as the firms can increase their market power in the local markets, as well as smoothing electricity demand with adjacent markets. Therefore, these three features are the natural candidates of the merger determinants and we first investigate whether these three candidates indeed have any impacts on the production cost of electricity and/or electricity prices.

Our estimation results confirm that the cost reduction is greater when the difference in the tangible and intangible asset compositions of the merged firms is larger; the mergers exhibiting a feature of vertical integration—a greater difference in the tangible asset compositions—lead to pro-competitive effects, and the mergers with a different strength in the downstream market—a greater difference in the intangible asset compositions—also lead to pro-competitive effects. Conversely, geographical proximity does not exert any significant effect on the production cost. To reveal the mechanism that creates these cost synergies, we further consider the firms’ post-merger outputs and capital utilization rates. We find that mergers with a greater difference in asset composition are associated with higher total output and improvements in capital utilization. These observations suggest, together with the finding above, that one of the mechanisms creating cost synergies is the following. When a merger take place among firms with different asset composition, firms are able to utilize their joint assets more efficiently owing to the complementarities of assets, which translates into a decrease in production costs and an increase in total production quantity. To distinguish the merger incentive seeking for market power from the incentive seeking for cost synergies, we investigate how electricity prices change after mergers. We find that the merger itself increases electricity prices. At the same time, we also find that the cost synergies partially pass through to electricity prices and, as a result, the pass-through effect generally cancels out the increase in electricity prices. We confirm that our results are robust to an endogeneity of selection on observables by estimating the semiparametric difference-in-differences model.

We then investigate the merger patterns firms choose based on their own incentives. To do this, we analyze the determinants of the firms' choices of merger counterparts, which allow us to understand those merger patterns chosen when firms maximized their economic value. Using the data, we employ two approaches—a reduced-form approach and a structural approach—to analyze which of the pairwise variables for acquirers and targets affect the likelihood of mergers. We find that firms are more likely to merge when the degree of overlap in service areas increases. However, the differences in the composition of tangible and intangible assets do not affect these merger decisions. Combining the pre- and post-merger analyses, we conclude that a merger of firms with different tangible and intangible assets tends to achieve cost synergy. However, private firms tend to focus only on market competition and do not necessarily care about the sources of cost synergy. In this regard, the merger pattern under private incentives may not perfectly align with the socially desirable merger pattern because there may be a discrepancy between them when the expected cost synergies are small. These results imply that merger review by antitrust authorities is helpful for enhancing social welfare.

The paper relates to several strands of the extant literature. First, the analysis contributes to the literature on the effects of mergers, which comprises a vast body of research; a number of papers including Andrade, Mitchell and Stafford (2001), Ashenfelter, Hosken and Weinberg (2014), and Kwoka (2014) provide useful reviews of the existing empirical work. For the most part, event and profit studies dominate the literature with the possible exception of some industries such as banking (Peristiani (1997), Focarelli and Panetta (2003) and Allen, Clark and Houde (2014)), food plants (McGuckin and Nguyen (1995)), electricity (Fabrizio, Rose and Wolfram (2007) and Kwoka and Pollitt (2010)), and healthcare (Harrison (2011) and Dafny, Duggan and Ramanarayanan (2012)). Together, these studies document how prices, production costs, and the quality of goods change following mergers.

In addition, several studies consider the plant- or facility-level effect of mergers, including Braguinsky, Ohyama, Okazaki and Syverson (2015), Blonigen and Pierce (2016), and Eliason, Heebsh, McDevitt and Roberts (2020). However, most of these do not analyze which of the merger characteristics including the combination of acquirer and target characteristics drive the cost efficiency. The only exceptions we are aware of are Ashenfelter, Hosken and Weinberg

(2015) and Miller and Weinberg (2017), both of which include the combination of production facilities and distribution channels of the acquirer and target, and subsequently identify that production reallocation creates cost synergies. We further extend these insights by examining the cost data directly and exploiting the variation in mergers, whereas Ashenfelter, Hosken and Weinberg (2015) and Miller and Weinberg (2017) infer cost synergies from price data (along with the optimality of pricing) without the actual cost and the exploitation of geographical variation in a single merger.

Second, we also contribute to the literature on merger determinants and value creation. Why firms merge and how mergers create value are important questions, not only in industrial organization, but in other fields such as corporate finance (Shleifer and Vishny (2003) and Devos, Kadapakkam and Krishnamurthy (2009)) and macroeconomics (Jovanovic and Rousseau (2002) and Jovanovic and Braguinsky (2004)), as well as several empirical studies on the banking industry, such as Focarelli, Panetta and Salleo (2002). With recent developments in the structural approach to estimating matching models (e.g., Fox (2018)), some studies estimate the merger value function as in Akkus, Cookson and Hortaçsu (2016) and Uetake and Watanabe (2019). However, these only examine firm merger decisions, not their consequences. Indeed, only a few studies explicitly connect the determinants of mergers and their outcomes. For instance, Cunningham, Ederer and Ma (2019) find that overlap in the product space makes merger more likely, which further affects future R&D and product development. To our knowledge, the current analysis is the first to analyze the connection between merger determinants and market outcomes.

The remainder of the paper is organized as follows. Section 2 describes the historical background of the Japanese electricity industry and the data used in the empirical analysis. Section 3 empirically examines which merger characteristics affect post-merger behavior and market outcomes, whereas Section 4 examines the determinants of mergers. Section 5 provides some policy implications and Section 6 concludes.

2 Industry Background and Data

2.1 Historical and Institutional Background

The Japanese electric utility industry commenced in 1883, with the founding of the Tokyo Electric Light Co. (Tokyo Dento), followed by the entry of new firms in large cities such as Tokyo, Osaka, and Kyoto in the late 1880s. Those companies generated, transmitted, and distributed electricity to their retail customers, mainly to supply electricity for lighting, and primarily by small-scale thermal power plants located close to their consumers. In the 1900s, the industry experienced rapid growth, both in terms of the number of firms and total production, for two main reasons. There were (i) technological innovation in long-distance transmission, which accelerated the entry of waterpower generators in rural areas, and (ii) a sharp increase in the demand of business customers using electricity for driving motors in factories, in addition to the demand of retail customers. Note that the peak demand times differed between retail and business customers, with retail customers primarily using electricity at night, whereas business customers used electricity more or less in the daytime when their factories were operating (Hirasawa, 1927: pp. 226–244).

Panel (a) of Figure 1 plots the number of electric utility firms operating in Japan between 1903 and 1929, excluding those companies generating power only for private use, such as railway companies. The industry is much less concentrated than in more recent years and it is remarkable that in 1914, when the WWI broke out, there were as many as 560 separate electric utility companies operating in Japan. Panel (b) of Figure 1 depicts power generation capacity over the same period. As shown, in the early 1900s, the capacity of thermal power, denoted by a dashed line, was much larger than that of waterpower, denoted by a dotted line. However, this reversed by the early 1910s because of a sharp increase in waterpower capacity. Subsequently, waterpower became the primary power source with thermal power only as an auxiliary source until after WWI.

Given this rapid development of the electric utility industry, the Japanese government started to prepare the legal framework for regulation. In 1896, it introduced a license system and companies wanting to commence an electric utility business needed a license from the government, specifying the service areas (Research Committee on Electric Utility Policy ed., 1965, pp.41–42).[1] It is notable that in managing the license system, the government accepted the overlap of company service areas (Miyake, 1951, p.36). In other words, the license system did not imply the granting of a regional monopoly. Indeed, there was strong competition for consumers between these electric utility companies with overlapping service areas. In 1932, and after a revision to the law, the government obtained wide-ranging authority over the industry, including price approval. This is the reason why we focus on the period up until 1930 in this analysis.

There was also a very active market for M&A activities during this period. Figure

[1]More formally, the Ministry of Communications legislated the Ordinance for Controlling Electric Utility Industry.

2 depicts the number of M&As over time. During the period we examine, no antitrust law or agency prevented mergers, and firms could engage in M&A activity without fear of government intervention. There was a particularly large spike in the number of M&As in 1921 and 1922, and a substantial number of M&As followed. These merger waves began partly because the Japanese Ministry of Communications urged companies to engage M&As as a means to increase the scale of their firms and to make utilization of power plants more efficient by coordinating plant operation (Miyake, 1951: pp. 42–43). Owing to this wave of M&A activity, the number of individual electric utility companies operating in Japan declined substantially in the 1920s, and the degree of industry concentration increased markedly.

2.2 Data Sources and Descriptive Statistics

Our primary data sources are from the various issues of the Handbook of Electric Utility Industry (Denki Jigyo Yoran), edited by the Ministry of Communications and first published in 1908 (for the 1907 issue), and the handbook continued to be published every year afterwards.[2] This handbook contains very detailed firm-, plant-, and even equipment-level data. From this source, we construct the dataset for 1914, 1918, 1922, 1926 and 1930. We select there years because during this period, there were a large number of electric utility companies and many M&As took place, which enables us to quantitatively analyze determinants both the determinants and the implications of these M&As. In addition, according to the Electric Utility Industry Law revised in 1932, the government imposed substantial regulations after the revision. Hence, the period before 1932 is desirable in the context of this analysis. The data we use (with the level in parentheses) are: the capacity of the power generator (equipment), the distance to the power transmission line (firm), the quantity of generated power and the capacity utilization rate (plant), service area (firm-county), expenditure and its breakdown (firm), revenue and its breakdown (firm), and financial data (firm). In addition, we use the data on M&As. All the M&As and the participant firms in the electric utility industry are recorded in the handbook for each year. We compiled a complete list of those M&As that took place from 1917 to 1930 using all the handbook issues.

The data are from various sections of the handbook. As the list of firms covered in each section differs slightly, we first separately collect and then merge the data for each section. We drop observations if relevant information is missing.[3] More specifically, to perform compre-

[2]From the 1907 to the 1910 issue, the Communication Bureau of the Ministry of Communications edited the handbook; from the 1911 issue onward, the Electricity Bureau of the Ministry of Communications, newly founded to administer the electric utility industry, was responsible for its editing.

[3]The number of firms reported in Figure 1 in 1914, 1918, 1922, 1926, and 1930 are 437, 556, 647, 633, and

hensive firm-level analysis, we drop observations if there are one or more missing observations for capacity, transmission line distance, output, electricity-related *variable* expense, revenue from retail/business customers, and service area. Note that electricity-related *variable* expense includes the costs of maintaining both power plants transmission and distribution lines. However, we exclude fixed costs such as the construction cost of power plants and costs associated with extending the distribution and transmission lines. In addition, note that service area is at the municipality level. In the data, firms report the name of the municipality to which they supply electricity. The measurement units for capacity, sending line distance, output, and cost/revenue are kilowatts (kW), kilometers (km), megawatt hours (MWh), and one thousand Japanese yen, respectively. Throughout the paper, $t \in T = \{1, 2, 3, 4, 5\}$ denotes the sample years, corresponding to 1914, 1918, 1922, 1926, and 1930, respectively.

Panel (A) of Table 1 lists the firm-level variables in the data. During the sample period, there were a large number of firms with a great dispersion in firm size, which results in large standard deviations compared with their means. Most firms owned multiple plants and supply electricity in multiple service areas. Note that we report revenue from retail customers and business customers separately, and we can see that business customer revenue has grown much more rapidly than that of retail customers. In addition, the tenth row reports the number of firms in a given municipality. On average, more than two firms compete in a given service area. Unfortunately, while the capacity and output data are plant level, the municipality or prefecture supply is not available.

Panel (B) of Table 1 lists the variables associated with mergers. The first row shows the number of mergers that occurred between the previous period and the current period, i.e., there were 25 mergers between 1917 and 1918, 232 mergers between 1919 and 1922, 157 mergers between 1923 and 1926, and 142 mergers between 1927 and 1930. However, we are unable to match all relevant information with these observed mergers. Similar to above, we drop some observations if there are one or more missing observations for capacity, transmission line distance, electricity-related expense, revenue from retail customers, revenue from business customers, or service area, in order to perform comprehensive analysis.[4] The numbers of acquirers and targets indicate the number of firms remaining in our sample. As

583 firms, respectively. In terms of the number of firms, there is a large amount of missing data. However, in terms of capacity, the data cover about 88% of the industry. This is because small firms are more likely to be missing from one or more sections of the handbook.

[4]Note that as we do not use output data in the analysis in Section 4, the criteria for removing observations are slightly weaker than suggested above. The reported output data in Panel (B) of Table 1 are only for firms for which we are able to match output data and therefore come only from a subset of firms compared with other variables reported in the same table.

shown, the matching rate for targets is significantly worse than that for acquirers. This is because the coverage of the merger section in the handbook is more detailed than in the other sections and includes small firms that never appear in other sections. One immediate observation from the panel is that acquirers are significantly larger than the average firm and targets are significantly smaller across all dimensions.

3 Do Mergers Affect Post-Merger Outcomes?

The goal of this section is to examine which merger characteristics–the pairs of acquirer and target characteristics–affect post-merger behavior and market outcomes. In particular, we are interested in identifying which merger characteristics create cost synergies and thus potentially lead to changes in prices.

We must again emphasize that our dataset is ideal for studying these questions for three reasons. A first advantage is that during the period of our study, no antitrust authorities or antitrust laws existed that would serve to prevent merger. Typically, with the presence of an antitrust authority, we would observe only approved mergers. Any approved mergers would tend by their nature to be more socially desirable, and this could create biases in the estimation of the post-merger effects. We will discuss these issues more in Section 3.1. A second advantage of our dataset is that we observe a relatively large number of mergers. With the possible exception of a few industries, mergers do not occur frequently and thus the framework for analysis could be limited. Lastly, the data contain detailed firm- and plan-level variables. In some industries, the only available data are firm-level balance sheet information and/or stock prices. Without detailed production and pricing data, identifying the mechanisms for any post-merger effects would be very challenging.

We first estimate a standard two-way fixed effects model in Section 3.1. However, it is natural to suspect that the effect of mergers are heterogenous depending on other firm-level and market-level variables. Also, the parallel trend assumption may only hold conditional on these variables. If so, the estimated parameter would be difficult to interpret. To address this concern, we also estimate a semiparametric model proposed by Abadie (2005) in Section 3.2.

3.1 Difference-in-Differences with Covariates

In this section, we examine which merger characteristics affect post-merger production cost, electricity prices, total output, and asset utilization. We first consider the production cost of electricity to identify which merger characteristics induce cost synergies. Then, we examine the effect of merger characteristics on prices. Finally, we investigate total output and the asset utilization pattern of firms to reveal the mechanism through which firms create cost synergies.

Throughout this subsection, we employ an empirical framework equivalent to the two-way fixed effects difference-in-differences estimator to quantify how mergers affect costs, prices, total outputs, and asset utilization.[5] The specification is as follows:

$$\Delta \ln y_{it} = \beta_t + \phi d_{it} + d_{it}\boldsymbol{m}_{it}\boldsymbol{\mu}' + \Delta \ln \boldsymbol{x}_{it}\boldsymbol{\beta}' + \epsilon_{it},$$

where $\Delta \ln y_{it} = \ln y_{it} - \ln y_{i,t-1}$ and $\Delta \ln \boldsymbol{x}_{it} = \ln \boldsymbol{x}_{it} - \ln \boldsymbol{x}_{i,t-1}$ are the first differences in logarithms of the dependent variable and the logarithm of a vector of firm characteristics, d_{it}, "*Merger Dummy*," is an indicator variable that takes a value of one if firm i experiences any merger in year $t' \in [t-1, t)$ in the data and zero otherwise, $\boldsymbol{m}_{it}$ is a vector of merger characteristics that firm i experiences during the interval of $[t-1, t)$, and ϵ_{it} is an error term assumed to be independent.[6] This specification is equivalent to the two-way fixed-effects regression described in Goodman-Bacon (2019).[7] By employing this specification, we can control for endogeneity–selection on observables–by including $\Delta \boldsymbol{x}_{it}$. For example, if larger firms tend to acquire other firms, we control such an endogeneity through $\Delta \boldsymbol{x}_{it}$. We further ease this endogeneity concern using a semiparametric approach proposed by Abadie (2005) in Section 3.2.

For $\boldsymbol{m}_{it}$, we include three variables, motivated by existing studies and the institutional features of our chosen industry. First, we specify "*Total Overlap Fraction*," which reflects the fraction of overlapping service areas between an acquirer and its targets and follows Akkus, Cookson and Hortaçsu (2016). The merged firms may be able to reallocate their production or benefit from economies of scale when acquirers and targets overlap in their

[5] The standard two-way fixed effects difference-in-differences model is typically specified as $y_{it} = \alpha_i + \alpha_t + \beta D_{it} + \gamma X_{it} + e_{it}$ where y_{it}, α_i, α_t, D_{it}, X_{it} and e_{it} denote outcome variable, individual fixed effects, time fixed effects, treatment indicator, other control variables and error term and β and γ are the parameter to be estimated. Taking first difference of each variable results in the specification we employ in this paper.

[6] We use a merger that occurred during $[t-1, t)$ to construct the merger characteristics at time t. This is because in the data, the reporting of the outcome variables is typically at the joint entity level for the year following a merger. For example, if i and j merge in the middle of 1920, the variables are reported separately for i and j in 1920 and jointly from 1921 onward.

[7] Econometrically, as shown in Goodman-Bacon (2019), this specification estimates a weighted average of treatment effects on treated (ATT) of all possible pairwise group comparison of merged entities and control firms at different merger timing. For the estimated coefficient to be interpreted as ATT, we assume that the mergers have constant ATT across groups and time conditional on $\boldsymbol{m}_{it}$.

operating markets, and the purpose of *Total Overlap Fraction* is to capture these effects. Formally, *Total Overlap Fraction* is defined as follows:

$$\text{Total Overlap Fraction}_{i,t} = \frac{\sum_m I_{m,i,t-1} \cdot J_{m,i,t-1}}{\sum_m I_{m,i,t-1} + \sum_m J_{m,i,t-1}},$$

where $I_{m,i,t}$ is an indicator function that takes a value of one if firm i operates in market m in year t and zero otherwise and $J_{m,i,t}$ is an indicator function that takes a value of one if any of firm i's target operates in market m in year t and zero otherwise. For example, when firm i operates in four markets, A, B, C, and D, and firm j operates in three markets, A, B, and E, with two overlapping markets A and B, then the variable takes a value of 2/(4+3) when firm i and j merge. Note that when a firm acquires multiple firms, we combine the markets of all targets as the target markets.

In addition, we include two more variables, "*Difference in Tangible Assets*" and "*Difference in Intangible Assets*," which aim to capture the differences in the pre- and post-merger asset compositions. In terms of tangible assets, generation capacity and distribution facilities are the two main assets in the electricity industry. A firm that has large generation capacity but no distribution facilities, for example, may improve production efficiency by merging with a firm that has an advantage in distribution facilities. In this way, to enhance productivity, it is important to have a good composition of both types of assets, and via mergers, firms may improve their asset composition. Thus, to capture the efficiency gain from mergers, we first define *Tangible Assets Composition* as a ratio of "the total power generating capacity" to "the total length of transmission line" and *Difference in Tangible Assets* as the *pro forma* difference in tangible assets composition. *Difference in Tangible Assets* can be regarded as the degree of vertical mergers. The industry has a vertical structure, and firms focusing more on the upstream, i.e., power generation, might not compete directly with firms focusing more on the downstream, i.e., electricity transmission and distribution. Mergers between these firms with vertically different focuses may happen to increase the allocative efficiency of the merged entities in the use of factor inputs, which is a similar mechanism and incentive discussed in the literature of vertical mergers.

Similarly, we use reachable customers as a representative proxy variable for intangible assets.[8] As discussed, there are two types of customers in the electricity industry during this period; retail customers demanding electricity at night and business customers demanding

[8] Indeed, we know that a firm's ability to reach customers contributes to an increase in firm value. Firm customers are important considerations when calculating the financial value of firms in M&As. See Gupta, Lehmann and Stuart (2004), for example, for the quantitative analysis of the value of customers.

electricity during the day. Consider a waterpower plant that can continuously produce electricity throughout the day. If this firm can only reach retail customers, any production capacity during the day may go unused. However, merging with firms with different customer compositions may allow firms to smooth electricity demand, and this may increase their efficiency. To capture this aspect, we formally define *Intangible Assets Composition* as the fraction of the firm's revenue from business customers to the total revenue. *Difference in Intangible Assets* is the *pro forma* difference in intangible assets composition. *Intangible Assets Composition*, in other word, measures the degree of difference in firms' strength in the downstream market.

Formally, we construct *Difference in Tangible Assets*, *Difference in Intangible Assets*, and the first differences in other variables as follows. For firms that do not experience mergers, we take the simple first differences. For firms that experience merger, when firm i acquires any firm in year $t' \in [t-1, t)$, we calculate the difference using firm i's current value of the variable minus the sum of all merged firms' value of the variable in the previous period. For example, if firm i acquires firm j, we compute the difference by

$$\Delta \ln y_{it} = \ln y_{it} - \ln\left(y_{i,t-1} + y_{j,t-1}\right).$$

As the asset composition variables are defined as fractions and this definition may fail to capture the effects, we compute the differences using

$$\begin{aligned} \textit{Difference in Tangible Assets}_{it} &= \left| \frac{C_{it-1}}{LD_{it-1}} - \frac{C_{it-1} + \sum_{j \in Tar_{it}} C_{jt-1}}{LD_{it-1} + \sum_{j \in Tar_{it}} LD_{jt-1}} \right|, \\ \textit{Difference in Intangible Assets}_{it} &= \left| \frac{BC_{it-1}}{TR_{it-1}} - \frac{BC_{it-1} + \sum_{j \in Tar_{it}} BC_{jt-1}}{TR_{it-1} + \sum_{j \in Tar_{it}} TR_{jt-1}} \right|, \end{aligned}$$

where C_{it} and LD_{it} respectively denote the capacity and the line distance of firm i in year t, BC_{it} and TR_{it} denote the revenue from business customers and total revenue (the sum of revenues from business and retail customers) for firm i in year t, respectively, and Tar_{it} denotes the set of firms that i has acquired between $[t-1, t)$. For both variables, if firms acquire other firms with larger differences in asset composition, the absolute value the variables becomes larger. For example, when firm i with a capacity of 10 and a line distance of 20 acquires firm j with a capacity of 5 and a distance of 5, the tangible asset composition changes by $|\frac{10}{20} - \frac{10+5}{20+5}| = |0.5 - 0.6| = 0.1$.[9]

[9] Similarly, when firm i with revenue of 10 from business customers and revenue of 20 from retail customers

There are three important notes. First, the parameters of interest are the vector of $\boldsymbol{\mu}$ rather than ϕ. In other words, we are interested in what types of mergers (e.g. whether or not two firms are located closely each other) drive the changes in the merger outcomes, rather than whether or not mergers themselves drive the changes in the merger outcomes. Thus, our objective here is to examine the effects of merger characteristics on outcomes by comparing outcomes *among* merged firms, not *among* the set of merged firms and the set of firms that Second, related to this, the absence of an antitrust authority is important to identify μ. To clarify, suppose that the change in prices is determined by the following specification:

$$\Delta \ln p_{it} = \beta_0 + \phi d_{it} + d_{it}\boldsymbol{m}_{it}\boldsymbol{\mu}' + \Delta \ln \boldsymbol{x}_{it}\boldsymbol{\beta}' + \epsilon_{it},$$

and the antitrust authority approves mergers only as long as they do not increase prices, i.e., $d_{it} = 1$ only if $\Delta \ln p_{it} \leq 0$. This selective approval process naturally induces biases in ϕ and $\boldsymbol{\mu}$. Finally, we employ one-period differences in the analysis. In the literature, the results suggest the effects of mergers take time to realize. For example, Focarelli and Panetta (2003) find that the short- and long-run effects of mergers on prices are qualitatively different while Eliason, Heebsh, McDevitt and Roberts (2020) demonstrate that acquired facilities only gradually change and it takes about six months to realize fully the effects of a merger. In our context, what we measure are the long-run effects of mergers, because a one-period difference actually corresponds to a four-years difference.

3.1.1 Unit Production Cost

To examine whether there are any cost synergies associated with mergers, we first regress the difference in the logarithm of unit production cost on d_{it}, $d_{it}\boldsymbol{m}_{it}$, $\Delta \ln \boldsymbol{x}_{it}$ and other controls. By doing so, we aim to identify the firm and merger characteristics that create cost synergies. Here, unit production cost is the electricity-related *variable* expense divided by total output, intended to capture average variable cost.[10] To better interpret the results, we normalize $\boldsymbol{m}_{it}$ so that all variables have a standard deviation of one. By doing so, we can interpret the estimated coefficients as the difference in outcome from a one-standard

acquires firm j with revenue of 5 from business customers and revenue of 5 from retail customers, the tangible asset composition changes by $|\frac{10}{20} - \frac{10+5}{20+5}| = |0.5 - 0.6| = 0.1$.

[10]Ideally, we would prefer to quantify separately the effects of mergers on fixed and marginal costs. However, as the economic and accounting concepts of cost differ, it is difficult to define accurately the marginal cost using the expense data. However, given that the electricity-related variable expense includes the maintenance costs that have both fixed and marginal cost components, we expect this would be a mix of some fixed and some marginal costs.

deviation difference in the independent variable. In addition, throughout this subsection, we include other controls, including the constant and the yearly and prefecture-level service area fixed effects.

Table 2 presents the results. We adopt several specifications with and without $\boldsymbol{m}_{it}$ and $\Delta \ln \boldsymbol{x}_{it}$. To observe the effects of mergers and their characteristics, we estimate three models (i), (ii), and (iii) without $\Delta \ln \boldsymbol{x}_{it}$. To explicitly control for each firm's own investment, we estimate another three models (iv), (v), and (vi) with $\Delta \ln \boldsymbol{x}_{it}$. The first and fourth columns provide the results without the detailed merger characteristics, $\boldsymbol{m}_{it}$; the other columns provide the results with the detailed merger characteristics, partially as in models (ii) and (v) or fully as in models (iii) and (vi).

In all models, when looking at the coefficients on the merger dummy, ϕ, none of the specifications exhibit statistically significant effects, indicating that there are no cost synergies arising from mergers. The existing studies often document that a merger itself reduces production costs. However, our results suggest that mergers do not create cost synergies per se. Instead, cost synergies appear to come from merger characteristics, i.e., cost synergies arise when firms with different asset compositions merge. The estimated coefficients on $\boldsymbol{m}_{it}$ are consistent across all specification, with statistically insignificant coefficients on *Total Overlap Fraction* and statistically significantly negative coefficients on both *Difference in Tangible Assets* and *Difference in Intangible Assets*. These results imply that merging with a firm that has many overlapping service areas does not lead to cost synergies, whereas merging with a firm that has larger differences in tangible and/or intangible asset compositions lowers production costs. As noted, this synergy may arise because the merged firm is able to smooth their production by utilizing different types of assets after merger. Therefore, for mergers to be socially desirable, which we call "compatible mergers," it is important to have appropriate pairs of firms. Also, in specifications (iv) to (vi) with $\Delta \ln \boldsymbol{x}_{it}$, the coefficients on the difference in capacity, $\Delta \ln(\text{Capacity})$, are statistically significantly negative, which suggests that there are economies of scale in production.

3.1.2 Post-Merger Changes in Prices

We now turn to investigate how mergers affect electricity prices. To this end, we use the same empirical specifications as in the previous analysis, replacing the unit production cost with the average price of electricity, as well as adding the difference in the average number of firms, $\Delta \mathit{Avg\ \#\ of\ Firms}_{it}$, as an additional independent variable, to control for the effects of competition intensity on prices. Formally, we define the average price of electricity as electricity-related revenue divided by total output and $\Delta Avg\ \#\ of\ Firms_{it}$ as

$$\Delta Avg\ \#\ of\ Firms_{it} = Avg\ \#\ of\ Firms_{it} - Avg\ \#\ of\ Firms_{i,t-1},$$

where Avg # of Firms_{it} is calculated by counting the number of firms in each county where firm i operates at time t and calculating its average.

Table 3 presents the estimation results, which are qualitatively similar to Table 2. There are four important observations in this table. First, the estimated coefficients on *Merger Dummy* vary across specifications. In the first and fourth columns, the estimated coefficients are very close to zero. When adding more variables as in specifications (ii) and (v), however, the estimated coefficients become larger. In the full specification as in specifications (iii) and (vi), even the coefficients are estimated to be statistically significantly positive. These observations enable us to infer that even though the merged firms do not seem to increase electricity prices on average in specifications (i) and (iv), it does not necessarily mean that the mergers have no effects on pricing. In fact, we can see that the mergers themselves increase prices significantly, both statistically and economically, as in specifications (iii) and (vi). At the same time, the estimated coefficients for *Difference in Tangible Assets* and *Difference in Intangible Assets* are statistically significantly negative. Thus, although a merger increases the price, when a merger occurs between firms with large differences in asset composition, the overall price may decrease owing to the cost synergies arising from *Difference in Tangible Assets* and *Difference in Intangible Assets*.

Second, another important observation concerns the quantitative differences between Tables 2 and 3. When we compare the coefficients for *Difference in Tangible Assets* and *Difference in Intangible Assets*, the absolute values are always greater in Table 2 than in Table 3, which suggests that cost synergies arise when merged firms have different asset compositions and the cost synergies translate into price reductions. However, by comparing the magnitude of these coefficients, we can see that it does not fully pass through to the price.

Third, even though we expect the coefficients on ΔAvg # of Firms to be negative, the results show that they are not statistically different from zero. Standard economic theory tells us that when there is a merger, the intensity of competition decreases, which leads to an increase in prices. However, our results do not support this argument. This discrepancy may be because we do not have a good measure of prices. Ideally, if we were to observe data on prices in each county, we could compare the prices within a firm across the county to discern the effects of the change in competition intensity. However, the aggregation of our price data is at the firm level. Therefore, we need to use the average number of firms instead of the number of firms in each county, which makes it difficult to obtain a precise estimate for the effects of competition intensity.

Lastly, the estimated coefficients on $\Delta \ln(\text{Capacity})$ and $\Delta \ln(\text{Line Dist.})$ also suggest important implications. As shown in Table 2,there may be economies of scale. When we compare the estimates of the coefficient for $\Delta \ln(\text{Capacity})$ in Tables 2 and 3, the absolute value is always larger in Table 2. As discussed, this also suggests that the reductions in cost pass through to the price, but not fully. Another interesting comparison concerns the estimates of the coefficient for $\Delta \ln(\text{Line Dist.})$ in Tables 2 and 3. The coefficient is not statistically significant in Table 2, suggesting that extending the distance of the transmission line creates fixed costs, but does not increase or decrease variable costs. Conversely, from the viewpoint of revenue, the estimated coefficient for $\Delta \ln(\text{Line Dist.})$ is positive and statistically significant in Table 3. These observations imply that firms may perhaps extend their transmission lines to reach out to customers with a higher willingness to pay.

3.1.3 Total Output and Capital Utilization Rates

Although Table 2 provides evidence concerning the source of cost synergies, it is silent about the mechanism creating these cost synergies. To reveal the mechanism, we investigate further the total output, capacity utilization, and transmission line utilization for the firms in Tables 4, 5 and 6, respectively. All tables presents the estimation results with the same specifications as in Table 2, except for the dependent variable. Now the dependent variables in Tables 4, 5, and 6 are now the differences in the logarithms of total output, the capacity utilization rate, and the transmission line utilization rate, respectively. Here, we define the rates of capacity and transmission utilization as the fraction of total electricity production to the capacity of power generation and the distance of the power transmission line, respectively. Those two variables should capture how intensively power generation capacity and power transmission line are used.

Table 4 presents the results for total output. When looking at specification (iv), the estimated coefficient on Merger Dummy is positive and statistically significant, which may be interpreted as merged firms increase total output. However, as we add more detailed merger characteristics variables, $\boldsymbol{m}_{it}$, the significance disappears and the sign even changes, suggesting that mergers themselves do not contribute to the increase in output, rather some other merger characteristics drive the increase in output. We support this hypothesis by the fact that both coefficients on *Difference in Tangible Assets* and *Difference in Intangible Assets* are positive and statistically significant.

Taken together with Table 2, these results suggest that the complementarity of assets is the source of the cost synergies, thereby providing insights into the mechanism of cost synergy creation. Consider a firm with a large production capacity but a relatively short transmission line. This firm may be unable to utilize its production capacity efficiently because its relatively short transmission lines may constrain its ability to supply electricity to customers. However, if this firm merges with one with long transmission lines but relatively small production capacity, the merged firm would be able to utilize both its production capacity and transmission lines more efficiently. As a result, firms may be able to increase output by lowering their production cost.

To confirm this hypothesis, we now replace total output with the utilization rates of capacity and transmission lines. Tables 5 and 6 provide the results for the capacity utilization rate and the transmission line utilization rate, respectively. Note that, by construction, some of the coefficients in the last three columns have identical estimates as in Table 4.

Both Tables 5 and 6 reconfirm the findings in Table 4. In all specification, the estimated coefficients on *Difference in Tangible Assets* and *Difference in Intangible Assets* are positive and statistically significant. These results enable us to conclude as follows: when firms with different asset compositions merge, the merged firm can utilize both types of assets more efficiently, such that an improvement in asset utilization rates results in lower production costs and higher total output.

3.2 Semiparametric Difference-in-Differences

The difference-in-differences estimator in Section 3.1 requires that the average outcomes for the treated group (firms experienced mergers) and control group (firms not experienced mergers) would have followed parallel paths over time in the absence of the treatment (mergers). However, as shown in Table 1, pre-treatment characteristics are unbalanced between the treated and the untreated. If we believe that these pre-treatment characteristics are associated with the dynamics of the outcome variables, the estimated parameters in Section 3.1 may not have any meaningful interpretation. To control for the potential non-parallel outcome dynamics for the treated and untreated groups caused by the pre-merger characteristics, we use an estimator proposed by Abadie (2005) to estimate the average treatment effect on treated (ATT). By assuming the standard parallel trend assumption *conditional on* *pre-merger characteristics*, we can express ATT by the first difference of outcome variables weighted by a function of the propensity scores as

$$E[y_{it}^{merger} - y_{it}^{nomerger}|d_{it}] = E\left[\frac{(y_{it} - y_{i,t-1})}{Pr(d_{it} = 1)}\frac{(d_{it} - Pr(d_{it} = 1|X_{i,t-1}))}{(1 - Pr(d_{it} = 1|X_{i,t-1}))}\right],$$

where y_{it}^{merger}, $y_{it}^{nomerger}$, y_{it} and $X_{i,t-1}$ denotes the outcome variable of firm i at time t if it experiences mergers, if it does not experience merger, the outcome variable under the observed treatment, and pre-merger characteristics, respectively. Furthermore, the estimator proposed by Abadie (2005) allows us to estimate the linear least square approximation to ATT conditional on $\boldsymbol{m}_{it}$, $E[y_{it}^{merger} - y_{it}^{nomerger}|d_{it}, \boldsymbol{m}_{it}]$.

Table 7 presents the estimation results where first to fifth columns show the estimation results with logarithm of unit production cost, average prices, total output, capital utilization rates and line utilization rates as the outcome variable, respectively. Here, when computing propensity scores, we use the logarithm of the capacity and length of transmission line, year and prefecture-level service area fixed effects, and a dummy variable indicating whether the firm has other types of business outside the electric utility industry. The results presented in each column correspond to specification (vi) in Tables 2, 3, 4, 5, and 6.

There are two important observations. First, qualitatively, the sign of the estimated coefficients on *Difference in Tangible Assets* and *Difference in Intangible Assets* in Table 7 are all consistent with the results in Section 3.1, which confirm that the results on these coefficients are robust. On the other hand, quantitatively, the magnitude of the estimated coefficients on *Difference in Tangible Assets* and *Difference in Intangible Assets* are much larger or smaller in Table 7, compared to the previous results. This difference suggests that the latter is more economically significant than we would conclude from a standard two-way fixed effects model.

Second, although the results presented here are qualitatively same as the results presented in Section 3.1, there are three differences. For the price regression, *Merger Dummy* is estimated positive and statistically significant in Table 3, but it is not statistically significant in Table 7. For the output regression, both *Merger Dummy* and *Total Overlap Fraction* are not statistically significant in the previous analysis in Table 4, but these are statistically significantly negative and positive, respectively, here in Table 7. Though these two approaches yield qualitatively different results for *Merger Dummy*, both suggest that mergers may exhibit a socially undesirable aspect, because the analysis in Section 3.1 predicts that mergers may induce price increase and the analysis in this section predicts that mergers may induce output reduction.

4 What Determines Merger Pairs?

In the previous subsection, we identify the source of compatible mergers, i.e., firms can benefit from merging with others with different asset compositions thanks to the cost synergies. Given these findings, in this section, we investigate the determinants of mergers, in particular, whether these characteristics of compatible mergers indeed affect the likelihood of mergers to occur. Understanding the merger determinants allows us not only to deepen our understanding of mergers but also to infer why firms merge and how mergers increase firms' value. Firms merge only if they expect increases in firm value as a combined entity. Therefore, the determinants of mergers should correspond to the determinants of firm value improvement. Here, we again take advantage of an unique feature of our data that there was no anti-trust authority during the sample period, which is essential to estimate the determinants of mergers. If mergers are selectively approved, the resulting data would suffer from selection issues, which makes our analysis very difficult. In the following subsections, we first employ a reduced-form approach to to understand what determines merger pairs in Section 4.1. Then, to check robustness of our results, we also employ a structural matching model proposed in Akkus et al. (2016) in Section 4.2.

4.1 Reduced-Form Evidence

To identify the determinants of mergers, the following approach is employed. We first create a hypothetical triple–acquirer, a target, and a year–for all possible combinations of firms and years.[11] We denote the year by t, the acquirer by i, and the target by j. Then, we create "*Merger Dummy*," denoted by D_{ijt}, for each triplet and assign a value of one if we observe that firm i acquires firm j in year $t' \in (t, t+1]$ in the data and zero otherwise.[12] We regress *Merger Dummy* on the combination of acquirer and target characteristics using

[11] When we construct the combination of firms, we take all possible combinations of firms that supply electricity within the same prefecture or in the bordering prefecture, because most mergers occur within such groups of firms. We also estimate the same model using all potential combinations of firms without any geographical restriction and the results are qualitatively the same.

[12] We define D_{ijt} in this manner because we are interested in the future merger decision of firms given the current firm characteristics.

a Probit model. Formally, we estimate the following model:

$$D_{ijt} = \begin{cases} 1 & \text{if} \quad D^*_{ijt} \geq 0 \\ 0 & \text{if} \quad D^*_{ijt} < 0, \end{cases}$$

with

$$D^*_{ijt} = \beta_0 + \boldsymbol{x}_{it}\boldsymbol{\beta}_1{}' + \boldsymbol{x}_{jt}\boldsymbol{\beta}_2{}' + \boldsymbol{x}_{ijt}\boldsymbol{\beta}_3{}' + \varepsilon_{ijt}$$

where $\varepsilon_{ijt} \sim N(0, 1)$, $\boldsymbol{x}_{it}$ denotes the vector of the acquirer's characteristics, $\boldsymbol{x}_{jt}$ denotes the vector of the terget's characteristics, and $\boldsymbol{x}_{ijt}$ denotes the vector of the acquirer and target pair specific characteristics. The main variables of interest for $\boldsymbol{x}_{it}$ and $\boldsymbol{x}_{jt}$ are the firms' power generation capacity, the distance of transmission lines, and the revenue share of business customers. We include these variables because we find that merger pair specific variables have some effect on post-merger outcomes. Moreover, capacity and transmission lines are two major tangible assets for the electricity companies and we consider the set of reachable customers an important intangible asset.

For $\boldsymbol{x}_{ijt}$, we use some interaction terms between $\boldsymbol{x}_{it}$ and $\boldsymbol{x}_{it}$, and "*Overlap Fraction*," which is defined as the fraction of overlapping service areas between the acquirer and target. Formally, we compute this value by dividing the number of markets where both firm i and j operate by the total number of markets where firm i and j operate, i.e.,

$$\textit{Overlap Fraction}_{ijt} = \frac{\sum_m I_{m,i,t-1} \times I_{m,j,t-1}}{\sum_m I_{m,i,t-1} + \sum_m I_{m,j,t-1}},$$

where $I_{m,i,t}$ is an indicator function that takes a value of one if firm i operates in market m in year t and zero otherwise. By estimating this model, we are able to quantify the combination of firm characteristics that make mergers more likely to happen, which allows us to infer what firms seek when making merger decisions.

Table 8 summarizes the estimation results from the Probit model with other controls. All specifications include a constant term, and year and prefecture-level service area fixed effects as "*Other Controls*." The first column demonstrates the baseline result without having interaction terms, $\boldsymbol{x}_{ijt}$. The coefficients on the logarithm of acquirer's capacity and distance of transmission line are positive and statistically significant, implying that the firms with more assets are more likely to be acquirers. In the second column, we include *Overlap Fraction*, the interaction terms of capacities of acquirer and target and the interaction terms of line distance of acquirer and target. The most important observation here is that the coefficient on *Overlap Fraction* is positive and statistically significant, suggesting that mergers are more likely to occur when the firms overlap more in their operating markets. This result is robust for all the following specifications. When we include some interaction terms between acquirers and targets, we can see that, in specification (ii), the interaction term of acquirers' capacity and targets' capacity is positive, which indicates that large firms tend to purchase large firms. In the third and fourth specifications, however, the estimated coefficients for these interaction terms are no longer statistically significant. Moreover, none of the interaction terms, except "Overlap Faction," is statistically significant, implying that even those merger characteristics that enable firms to enjoy cost synergies do *not* increase the likelihood of mergers. This might be a somewhat surprising result, and we discuss a possible reason for this in Section 5. In the fifth column, we add the acquirer's and target's book value of asset. Although Akkus et al. (2016) finds that merger pairs are positive assortative with respect to book value of assets, we do not find such a pattern in this analysis.

4.2 Robustness Check: Matching Estimation

The estimation strategy employed in Section 4.1 is intuitive and useful to identify what determines merger pairs. However, it lacks a theoretical foundation. In this subsection, following the matching model proposed by Akkus et al. (2016), we estimate a structural model of merger decisions to check the robustness of our findings in Section 4.1.

We denote the total number of mergers in year y by M_y, the acquirer by $i \in \{1, 2, \cdots, \mathcal{I}\}$, and the target by $j(i) \in \{1, 2, \cdots, \mathcal{J}\}$. We assume that there is one national merger market every year and markets in different years are independent of one another. When firms i and j merge, the merger realizes a post-merger value $V_y(i, j)$, which is value that firms i and j would attain as a merged entity and the utility is transferable between firm i and firm j. Suppose that we observe two mergers: firm i acquires firm j and firm i' acquires firm j'. As described in Akkus et al. (2016), in the matching equilibrium, the revealed preference induces the following condition:

$$V_y(i, j) + V_y(i', j') \geq V_y(i, j') + V_y(i', j). \tag{1}$$

If this condition does not hold, either i or i' can offer utility transfer to j' or j so that both can achieve higher payoff than their observed match. See Akkus et al. (2016) for detailed description of the merger matching model and its equilibrium characterization.

Inequality (1) allows us to construct an estimation condition. We first specify $V_y(i, j; \beta)$

as

$$V_y(i, j; \beta) = X_{iy}\beta^a + X_{jy}\beta^t + X_{ijy}\beta^{at} + \eta_{ijy},$$

where X_{iy} is the acquirer characteristics, X_{jy} is the target characteristics, X_{ijy} is the acquirer and target pair-specific characteristics, and η_{ijy} is a match-specific error. We assume that η_{ij} is independently distributed across all possible (i, j) pairs. As in Akkus et al. (2016), we adopt the maximum score estimator developed by Fox (2018). Specifically, we construct the following objective function and estimate the parameter by maximizing it:

$$Q(\beta) = \frac{1}{2}\sum_{y}\sum_{i' \neq i}\sum_{i} 1\left[V_y(i, j(i)) + V_y(i', j(i')) - V_y(i, j(i')) - V_y(i', j(i))\right],$$

where $j(i)$ denotes the target firm that acquirer i merged in the observed merged pairs and $1[\cdot]$ is an indicator function that takes a value of one if the statement inside the bracket is true and zero otherwise. Note that the acquirer and target characteristics, including fixed effects, are canceled out in $V_y(i, j(i)) + V_y(i', j(i')) - V_y(i, j(i')) - V_y(i', j(i))$. Therefore, we can only identify the parameter on pair-specific characteristics, β^{at}.[13]

Table 9 presents the estimation results with three different specifications.[14] We employ the same specifications as in Section 4.1 and the same merger pair-specific variables for the specification of $V_y(i, j)$. As the maximum score estimation requires normalization of the parameter, we normalize the coefficient on *Overlap Fraction* to one, which is omitted from the table. Based on the results in Table 8, we expect that *Overlap Fraction* to have a positive coefficient.[15]

The first and second columns correspond to the specification in the third and fourth columns in Table 8. The results are qualitatively similar with no statistical significance other than *Overlap Fraction*. One qualitative difference between the structural estimation and the results in Table 8 is that the coefficient on the interaction term of acquirer's and target's book value of asset is estimated positive and statistically significant in Table 9. This observation means that matching pairs are positive assortative, which Akkus et al. (2016) also finds. The results in all specifications are broadly consistent with the argument in Section 4.1:

[13] Akkus et al. (2016) uses data on monetary transfer from acquirers to targets, which allows it to identify and estimate the parameter on the acquirer characteristics. Unfortunately, we do not have any data on acquisition value of the targets.

[14] We generate the confidence intervals using the subsampling procedure described in Akkus et al. (2016), where we set the subsample size to 60 out of 104 mergers in the data used in the estimation.

[15] Alternatively, we could normalize the norm of the parameter to one. The results are qualitatively similar.

The only robust determinants of merger is *Overlap Fraction* and other merger characteristics that affect post-merger outcome do not have statistically significant relationship with merger decisions.

5 Implications

5.1 Implications from Pre- and Post-Merger Analyses

In this subsection, we first summarize the results presented in the previous sections to derive some policy and managerial implications on the pre-merger incentives of firms and their post-merger consequences.

Firms' merger incentive does not seem to be perfectly aligned with social welfare; the estimated coefficients on *Merger Dummy* in Table 3 show that mergers are associated with increases in prices suggesting that firms seek for market power and the estimated constant term in Table 7 suggests that merged entities reduce output. At the same time, greater differences in tangible (production) asset composition create cost synergies, as in Tables 2, 3, and 4, which is consistent with the findings in Ashenfelter, Hosken and Weinberg (2015) and Miller and Weinberg (2017) where they find production reallocation creates cost efficiency. Also, our finding is consistent with the common argument that vertical mergers are pro-competitive. The new Vertical Merger Guidelines issued by the U.S. Department of Justice and Federal Trade Commission issued in June 2020 discusses pro-competitive effect of vertical mergers. Our findings that the degree of vertical mergers decreases both the production cost and electricity price provide such evidence.

Moreover, our results also demonstrate that greater differences in intangible asset composition (reachable customers) create cost synergies. These findings can partially explain why some new tech companies are often purchased by some incumbent firms, as these incumbents can diversify their product/production portfolios via merging with new tech companies that have different types of assets, as well as expanding their customer-bases via merging with new tech companies that have different type of customers. However, these factors that create cost synergies do not affect merger decisions, as in Table 8. Futhermore, Tables 3 and 7 suggest that cost synergies are partly pass through to prices, which means that the cost synergies may not lead to higher profit for acquirers. Therefore, the acquirers may not necessarily have an incentive to merge with target companies to create cost synergies.

These results have an immediate implication for antitrust policy. During the sample periods in this paper, there was no antitrust authority to review mergers. As a result, all proposed mergers occurred only if the merging parties agreed. If there were an antitrust authority to selectively approve mergers, it may have improved social welfare. Based on the estimates, we are able to distinguish between mergers that mainly seek market power from those that induce cost synergies. If an authority approved compatible mergers where the cost synergies offset the increase in prices, it may also have improved social welfare.

There are also some managerial implications can be derived from our results, which may be related to the literature on merger failures. "Merger failure" is a phenomena that a merged entity performs worse than proforma entities and, according to Christensen, Alton, Rising and Waldeck (2011), "Companies spend more than $2 trillion on acquisitions every year, yet the M&A failure rate is between 70% and 90%." In finance and management literature, researchers have extensively studied why mergers fail. The existing literature explain this phenomena by investigating overconfidence of CEOs (e.g., Malmendier and Tate, 2008), differences in corporate culture (e.g., Cartwright and Cooper, 1993; Weber and Camerer, 2003), empire building (e.g., Gantchev, Sevilir and Shivdasani, 2020), asymmetric information between acquires and targets (e.g., Bana-Estañol and Seldeslachts, 2011), and so on.[16] In this paper, we tackle this question by focusing on the detailed production and reachable customer data and find that merger decisions were dominated by the geographical proximity rather than potential synergies that they could have enjoyed, i.e., merger compatibility hinges on the differences in production asset composition and reachable customers, but these merger compatibility do not affect merger decisions.

5.2 Caveats and Limitations

There are several caveats and limitations in our analysis. First, this paper does not address why the firms merge to change their asset compositions rather than invest by themselves. In principle, if the firms wish to increase their power generation capacity or extend their power grid, they could invest themselves. It might be possible that, for example, a firm cannot build the waterpower plants they want due to geographical constraints. Such natural resource constraints may limit the ability of firms to expand their assets themselves. Second, we also do not address why asset compositions are suboptimal before mergers. There are several possible explanations; one is that there may have been changes in the demand structure and the firms attempt to adjust to these changes. Another is the growth process, which requires

[16] See Renneboog and Vansteenkiste (2019) for a more comprehensive literature review.

continuous adjustment of firm asset compositions. A third and related possibility is that it is not necessarily the case that merging two firms with different asset compositions improves efficiency, because the mergers only help firms that have suboptimal asset composition in the first place. This claim has further policy implications. For example, when we design bailout mergers, we first need to examine whether the asset composition of failing firms is suboptimal. When it is suboptimal, we can apply our results by selecting which firms to merge. However, if it is not the case, then we must use different criteria for choosing the merger counterpart. Finally, another conceptual limitation of our analysis is that our model cannot capture the effects of externalities arising from post merger competition on merger decisions of the firms, studied by Uetake and Watanabe (2019). Extending our framework to take into account such an effect might be a fruitful future direction.

6 Conclusion

In this paper, we empirically consider the implications of merger policy, using detailed data on the merger waves in the pre-WWII Japanese electricity industry when a competition authority did not yet exist. Our estimation results suggest that firms can enjoy cost synergies when merging with firms with greater differences in production asset composition and/or reachable customers. Such compatible mergers result in increases in capital utilization and total output. However, the sources of cost synergy do not affect the merger decision of firms. Rather, geographical overlap increases the likelihood of mergers. These results imply that the merger incentive of firms may not align with social welfare. Thus, a policy intervention that selectively allows mergers for a particular combination of firms may help increase social welfare.

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Table 1: Descriptive Statistics

Panel (A): Firm- and Branch-level Characteristics										
Year	1914		1918		1922		1926		1930	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
# of Firms	319		276		205		391		368	
Capacity	1837	8,919	2,370	7,832	4,068	10,913	5,889	25,647	9,958	46,055
Distance	63	111	132	210	265	424	303	1,101	621	2,320
# of Plants	1.53	1.35	1.98	1.70	2.46	2.49	2.64	4.98	3.09	5.77
Output	5,607	26,668	11,881	37,386	17,885	49,318	21,425	91,213	32,699	127,246
Electricity Cost	100	343	232	769	613	2,086	609	3,844	966	5,265
Rev. from RC	109	420	230	747	492	1,624	501	2,610	685	3,702
Rev. from BC	423	174	173	603	427	1,505	556	2,857	802	3,860
# of Business Area	2.88	3.18	3.71	4.45	4.42	5.93	3.54	8.29	3.86	9.55
# of Firms in each Area	2.04	1.42	2.31	1.53	2.69	1.83	2.92	2.10	2.53	1.79
Panel (B): Merger (Acquirers' and Targets') Characteristics										
Year	1914		1918		1922		1926		1930	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
# of Mergers	-	-	25		232		157		142	
# of Acquirers	-	-	15		95		74		62	
Capacity	-	-	5,465	14,283	4,729	9,543	12,933	27,616	29,399	57,724
Distance	-	-	343	396	323	522	934	1,505	1,517	2,509
Output	-	-	26,408	67,781	14,689	40,114	36,459	79,576	116,021	20,864
# of Business Area	-	-	6.87	9.17	5.41	6.49	8.96	11.95	11.95	17.98
# of Target	-	-	19		61		57		61	
Capacity	-	-	657	1,798	2,417	7,079	5,219	28,256	12,660	62,762
Distance	-	-	41	60	204	561	110	178	1081	4647
Output	-	-	2,534	7,277	5,007	19,870	34,117	192,848	53,041	210,275
# of Business Area	-	-	2.10	2.02	3.63	4.92	1.78	2.16	5.44	14.96

Note: Each row of Panel (A) reports summary statistics of firm-level variables in each of the sample year except # of Firms in each Area. The first to ninth row report the number of firms in the data, total capacity (in kW), sending line distance (in km), the number of power plants each firm operates, total output (in MWh), electiricity related variable expense (in thousand Yen), revenue from retail customers (in thousand Yen), revenue from business customers (in thousand Yen), and the number of counties where each firm supplies electricity. The tenth row, # of Firms in each Area, is summary statistics of county-level variable that counts the number of operating firms in each county. The first row in Panel (B) reports the number of M&As in each corresponding time period. The second to sixth row and the seventh to eleventh row report summary statistics of firm-level variables for acquirers and targets, respectivly. The definition of variables are the same as in Panel (A).

Table 2: Unit Production Cost

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	Δ ln UPC	Δ ln UPC	Δ ln UPC	Δ ln UPC	Δ ln UPC	Δ ln UPC
Merger Dummy	-0.0165	0.0913	0.254	-0.0908	0.0468	0.224
	(0.128)	(0.173)	(0.181)	(0.118)	(0.158)	(0.165)
Total Overlap Frac.		-0.0267	-0.0415		-0.0556	-0.0722
		(0.115)	(0.114)		(0.105)	(0.104)
Diff in Tang. Assets		-0.315***	-0.255***		-0.317***	-0.251***
		(0.0739)	(0.0762)		(0.0674)	(0.0694)
Diff in Intang. Assets			-0.235***			-0.257***
			(0.0797)			(0.0727)
Δ ln(Capacity)				-0.518***	-0.519***	-0.521***
				(0.0487)	(0.0480)	(0.0477)
Δ ln(Line Dist.)				0.00460	0.00404	0.0127
				(0.0670)	(0.0661)	(0.0656)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	776	776	776	766	766	766
Adjusted R^2	0.077	0.097	0.107	0.207	0.229	0.242

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Notes: Δ ln(Capacity) and Δ ln(Line Distance) represent the first differences of the firm's electricity generating capacity and the firm's length of transmission line, respectively. Other Controls include a constant term, year and prefecture-level service area fixed effects, and a dummy variable indicating whether the firm has other types of business outside the electric utility industry.

Table 3: Average Price of Electricity

	(i) $\Delta \ln(p)$	(ii) $\Delta \ln(p)$	(iii) $\Delta \ln(p)$	(iv) $\Delta \ln(p)$	(v) $\Delta \ln(p)$	(vi) $\Delta \ln(p)$
Merger Dummy	-0.0112	0.150	0.286*	-0.0716	0.120	0.277**
	(0.104)	(0.141)	(0.146)	(0.0912)	(0.123)	(0.127)
Total Overlap Frac.		-0.0851	-0.0968		-0.114	-0.128
		(0.0916)	(0.0911)		(0.0798)	(0.0789)
Diff in Tang. Asset		-0.283***	-0.231***		-0.287***	-0.227***
		(0.0584)	(0.0603)		(0.0509)	(0.0522)
Diff in Intang. Asset			-0.203***			-0.234***
			(0.0633)			(0.0549)
ΔAvg # of Firms$_t$	0.00688	-0.00653	-0.00770	0.0104	-0.00363	-0.00503
	(0.0257)	(0.0254)	(0.0253)	(0.0227)	(0.0223)	(0.0221)
$\Delta \ln$ (Capacity)				-0.468***	-0.470***	-0.472***
				(0.0372)	(0.0363)	(0.0359)
$\Delta \ln$ (Line Dist.)				0.115**	0.119**	0.127**
				(0.0522)	(0.0510)	(0.0504)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	756	756	756	743	743	743
Adjusted R^2	0.108	0.137	0.148	0.274	0.307	0.324

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Notes: Δ ln(Capacity) and Δ ln(Line Distance) represent the first differences of the firm's electricity generating capacity and the firm's length of transmission line, respectively. Other Controls include a constant term, year and prefecture-level service area fixed effects, and a dummy variable indicating whether the firm has other types of business outside the electric utility industry.

Table 4: Total Output

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	$\Delta \ln$ TO	$\Delta \ln$ TO	$\Delta \ln$ TO	$\Delta \ln$ TO	$\Delta \ln$ TO	$\Delta \ln$ TO
Merger Dummy	0.0635	-0.0484	-0.203	0.177*	0.0403	-0.128
	(0.127)	(0.172)	(0.180)	(0.104)	(0.140)	(0.146)
Total Overlap Frac.		0.0380	0.0521		0.0610	0.0768
		(0.114)	(0.114)		(0.0924)	(0.0917)
Diff in Tang. Assets		0.285***	0.228***		0.292***	0.230***
		(0.0735)	(0.0759)		(0.0596)	(0.0613)
Diff in Intang. Assets			0.223***			0.244***
			(0.0794)			(0.0642)
$\Delta \ln$ (Capacity)				0.591***	0.592***	0.594***
				(0.0431)	(0.0424)	(0.0420)
$\Delta \ln$ (Line Dist.)				0.335***	0.336***	0.328***
				(0.0587)	(0.0578)	(0.0573)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	787	787	787	771	771	771
Adjusted R^2	0.059	0.076	0.084	0.331	0.351	0.363

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Notes: Δ ln(Capacity) and Δ ln(Line Distance) represent the first differences of the firm's electricity generating capacity and the firm's length of transmission line, respectively. Other Controls include a constant term, year and prefecture-level service area fixed effects, and a dummy variable indicating whether the firm has other types of business outside the electric utility industry.

Table 5: Capacity Utilization Rate

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	$\Delta \ln$ CUR	$\Delta \ln$ CUR	$\Delta \ln$ CUR	$\Delta \ln$ CUR	$\Delta \ln$ CUR	$\Delta \ln$ CUR
Merger Dummy	0.171	0.00389	-0.172	0.177*	0.0403	-0.128
	(0.111)	(0.150)	(0.157)	(0.104)	(0.140)	(0.146)
Total Overlap Frac.		0.0908	0.107		0.0610	0.0768
		(0.0995)	(0.0988)		(0.0924)	(0.0917)
Diff in Tang. Assets		0.289***	0.225***		0.292***	0.230***
		(0.0642)	(0.0660)		(0.0596)	(0.0613)
Diff in Intang. Assets			0.253***			0.244***
			(0.0690)			(0.0642)
$\Delta \ln$ (Capacity)				-0.409***	-0.408***	-0.406***
				(0.0431)	(0.0424)	(0.0420)
$\Delta \ln$ (Line Dist.)				0.335***	0.336***	0.328***
				(0.0587)	(0.0578)	(0.0573)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	787	787	787	771	771	771
Adjusted R^2	0.033	0.059	0.074	0.147	0.174	0.189

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Notes: Δ ln(Capacity) and Δ ln(Line Distance) represent the first differences of the firm's electricity generating capacity and the firm's length of transmission line, respectively. Other Controls include a constant term, year and prefecture-level service area fixed effects, and a dummy variable indicating whether the firm has other types of business outside the electric utility industry.

Table 6: Line Utilization Rate

	(i) $\Delta \ln$ LUR	(ii) $\Delta \ln$ LUR	(iii) $\Delta \ln$ LUR	(iv) $\Delta \ln$ LUR	(v) $\Delta \ln$ LUR	(vi) $\Delta \ln$ LUR
Merger Dummy	0.165	0.0672	-0.0790	0.177*	0.0403	-0.128
	(0.121)	(0.163)	(0.171)	(0.104)	(0.140)	(0.146)
Total Overlap Frac.		0.0227	0.0363		0.0610	0.0768
		(0.108)	(0.107)		(0.0924)	(0.0917)
Diff in Tang. Assets		0.294***	0.240***		0.292***	0.230***
		(0.0695)	(0.0718)		(0.0596)	(0.0613)
Diff in Intang. Assets			0.213***			0.244***
			(0.0752)			(0.0642)
$\Delta \ln$ (Capacity)				0.591***	0.592***	0.594***
				(0.0431)	(0.0424)	(0.0420)
$\Delta \ln$ (Line Dist.)				-0.665***	-0.664***	-0.672***
				(0.0587)	(0.0578)	(0.0573)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	771	771	771	771	771	771
Adjusted R^2	0.062	0.082	0.091	0.304	0.325	0.338

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Notes: Δ ln(Capacity) and Δ ln(Line Distance) represent the first differences of the firm's electricity generating capacity and the firm's length of transmission line, respectively. Other Controls include a constant term, year and prefecture-level service area fixed effects, and a dummy variable indicating whether the firm has other types of business outside the electric utility industry.

Table 7: Semiparametric Difference-in-Differences

	(i) $\Delta \ln \text{UPC}$	(ii) $\Delta \ln(p)$	(iii) $\Delta \ln \text{TO}$	(iv) $\Delta \ln \text{CUR}$	(v) $\Delta \ln \text{LUR}$
Merger Dummy	0.0436	0.0229	-0.500***	-0.102	-0.0679
	(0.167)	(0.144)	(0.149)	(0.145)	(0.140)
Total Overlap Fraction	0.238	0.192	0.807**	0.0445	-0.334
	(0.406)	(0.351)	(0.335)	(0.344)	(0.319)
Diff in Tang. Asset	-0.0932***	-0.0868***	0.0675**	0.0676**	0.0862***
	(0.0347)	(0.0309)	(0.0338)	(0.0303)	(0.0287)
Diff in Intang. Asset	-0.507*	-0.393*	0.822***	0.588**	0.478**
	(0.280)	(0.236)	(0.275)	(0.272)	(0.242)
Observations	587	581	593	593	577

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Determinants of Mergers with All Firms

	(i) Merger Dum.	(ii) Merger Dum.	(iii) Merger Dum.	(iv) Merger Dum.	(v) Merger Dum.
ln(Acq. Capacity)	0.070**	-0.086	-0.077	-0.069	-0.100
	(0.033)	(0.065)	(0.076)	(0.088)	(0.111)
ln(Tar. Capacity)	0.029	-0.298***	-0.308**	-0.345***	-0.243
	(0.028)	(0.095)	(0.124)	(0.131)	(0.158)
ln(Acq. Line Dist.)	0.211***	0.296***	0.281***	0.286***	0.192*
	(0.048)	(0.083)	(0.100)	(0.103)	(0.107)
ln(Tar. Line Dist.)	-0.022	0.019	0.024	0.048	0.077
	(0.036)	(0.102)	(0.144)	(0.146)	(0.161)
ln(Acq. Capacity)		0.036***	0.022	0.036	0.026
×ln(Tar. Capacity)		(0.010)	(0.019)	(0.022)	(0.024)
ln(Acq. Line Dist.)		-0.001	-0.027	-0.018	-0.015
×ln(Tar. Line Dist.)		(0.015)	(0.033)	(0.035)	(0.034)
Overlap Fraction		3.835***	3.852***	3.856***	3.857***
		(0.325)	(0.327)	(0.331)	(0.338)
ln(Acq. Capacity)			0.018	0.008	0.003
×ln(Tar. Line Dist.)			(0.024)	(0.026)	(0.026)
ln(Acq. Line Dist.)			0.020	0.010	0.011
×ln(Tar. Capacity)			(0.025)	(0.028)	(0.027)
Acq. Frac. of Elect Rev.				-0.230	-0.213
				(0.339)	(0.339)
Tar. Frac. of Elect Rev.				0.210	0.114
				(0.375)	(0.383)
Acq. Frac. of Elect Rev.				-1.004	-0.741
×Tar. Frac. of Elect Rev.				(0.813)	(0.816)
ln(Acq. Book Asset)					-0.016
					(0.243)
ln(Tar. Book Asset)					-0.303
					(0.290)
ln(Acq. Book Asset)					0.017
×ln(Tar. Book Asset)					(0.019)
Other Controls	Yes	Yes	Yes	Yes	Yes
Observations	36858	36858	36858	36491	34543
Pseudo R^2	0.251	0.346	0.346	0.347	0.353

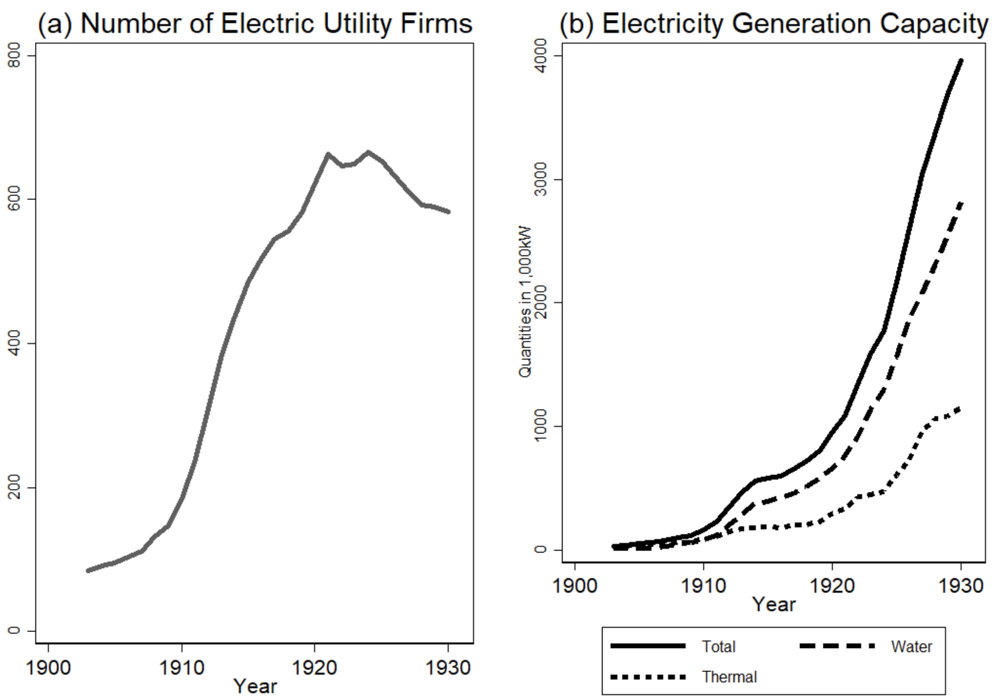
Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Note: The dependent variable, Merger Dum., is merger dummy for all specification. ln(Acq. Capacity), ln(Tar. Capacity), ln(Acq. Line Dist.), ln(Tar. Line Dist.), ln(Acq. Book Asset), ln(Tar. Book Asset), Acq. Frac. of BC and Tar. Frac. of BC represent the logarithm of acquirers' capacity, the logarithm of target's capacity, the logarithm of acquirers' length of transmission line, the logarithm of target's length of transmission line, the logarithm of acquirers' book value of asset, the logarithm of target's book value of asset, the acquirer's revenue share of business customers, and the target's revenue share of business customers, respectively. Other Controls includes a constant term, year fixed effects, prefecture-level service area fixed effects and a dummy variable whether the firm has other type of business outside the electric utility industry.

Table 9: The Structural Matching Model

	(i)	(ii)	(iii)
Dependent Var.	Merger Dum.	Merger Dum.	Merger Dum.
ln(Acq. Capacity)	0.002	0.003	0.005
×ln(Tar. Capacity)	(-0.004, 0.011)	(-0.001, 0.006)	(-0.003, 0.009)
ln(Acq. Line Dist.)	-0.005	0.003	0.007
× ln(Tar. Line Dist.)	(-0.008, 0.011)	(-0.006, 0.007)	(-0.005, 0.011)
ln(Acq. Capacity)	0.001	-0.002	-0.003
× ln(Tar. Line Dist.)	(-0.007, 0.009)	(-0.004, 0.006)	(-0.007, 0.007)
ln(Acq. Line Dist.)	0.002	-0.002	-0.010
× ln(Tar. Capacity)	(-0.010, 0.005)	(-0.006, 0.003)	(-0.011, 0.001)
Acq. Frac. of BC		-0.018	-0.006
×Tar. Frac. of BC		(-0.004, 0.011)	(-0.027, 0.145)
Acq. Book Value of Asset			0.009
×Tar. Book Value of Asset			(0.008, 0.010)
Observations	1,786	1,786	1,786
Inequality violations percentage	3.2%	3.1%	3.1%

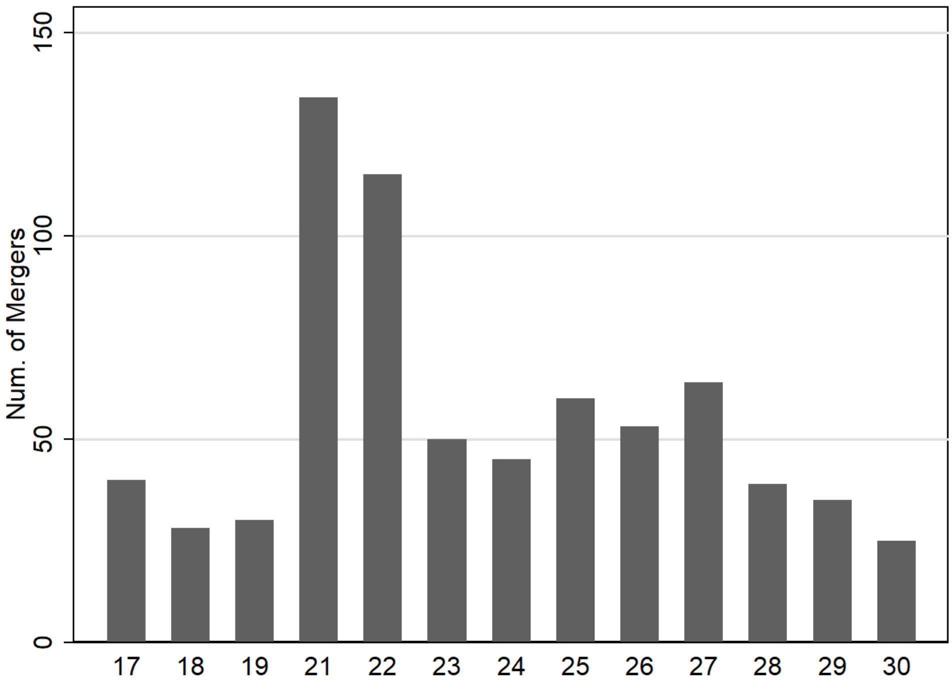
95% confidence interval in parentheses. Confidence intervals are calculated by subsampling. *Note*: ln(Acq. Capacity), ln(Tar. Capacity), ln(Acq. Line Dist.), ln(Tar. Line Dist.), ln(Acq. Book Asset), ln(Tar. Book Asset), Acq. Frac. of BC and Tar. Frac. of BC represent the logarithm of acquirers' capacity, the logarithm of target's capacity, the logarithm of acquirers' length of transmission line, the logarithm of target's length of transmission line, the logarithm of acquirers' book value of asset, the logarithm of target's book value of asset, the acquirer's revenue share of business customers, and the target's revenue share of business customers, respectively. The confidence intervals are generated by the subsampling procedure with the subsample size set to 60 out of 104 mergers in the data.

Figure 1: Evolution of the Industry



Source: Kurihara, 1964, Appendix, pp.16–18.

Figure 2: Number of M&As between 1917 and 1930



Source: Handbook of Electric Utility Industry, various issues. Due to a change in the data-reporting period, the number for M&As in 1920 and 1921 is summed in the column for 1921.

Appendix A: Merger Effects on Accounting Measure

The results presented in Section 3 are the post-merger effects on *economic* variables. In the literature, *accounting* variables often serve to quantify the post-merger effects. However, using accounting measures may suffer from the conceptual difference between economics and accounting. For example, the existence of goodwill in accounting measures can overestimate the value of acquired assets. In addition, reported profit is a complex composition of different accounting measures and may not correspond to economic profit.

To examine the validity of the use of accounting measure, we regress the difference in "*Return on Asset*" and "*Return on Equity*" on the same set of variables. Table A1 summarizes the estimation results. For both *ROA* and *ROE*, no variable has statistically significant coefficient, even though the results presented in Tables 2, 5 and 6 show that merger characteristics do affect firms' cost and behavior. This contradictory observation suggests that accounting measures are not appropriate to quantify the effects of mergers in this context.

Appendix B: Analysis on Merger Determinants with Subsample of Firms

Firms participating in M&A activities may systematically differ from those that have never experienced mergers. To check the robustness of the results presented in Section 4, we estimate the same model as in Table 8, using only those firms that have never appeared as an acquirer or a target in the data. Table B1 summarizes the estimation results. Qualitatively, the results are identical to those presented in Section 4.

Table A1: ROA and ROE

	(i) Δ ROA	(ii) Δ ROA	(iii) ΔROA	(iv) ΔROE	(v) ΔROE	(vi) ΔROE
Merger Dummy	-0.0102	-0.00345	-0.00523	-1.023	-1.073	-1.227
	(0.0136)	(0.0182)	(0.0189)	(0.811)	(1.076)	(1.121)
Δ ln(Capacity)	-0.00427	-0.00439	-0.00437	-0.103	-0.102	-0.101
	(0.00501)	(0.00502)	(0.00502)	(0.297)	(0.298)	(0.298)
Δ ln(Line Distance)	0.0142**	0.0140**	0.0139**	-0.105	-0.104	-0.110
	(0.00647)	(0.00647)	(0.00648)	(0.387)	(0.388)	(0.388)
Overlap Fraction		-0.0363	-0.0360		0.315	0.343
		(0.0744)	(0.0745)		(4.389)	(4.391)
Diff in Tangible Asset		-0.000196	-0.000230		-0.0000561	-0.00299
		(0.000362)	(0.000376)		(0.0213)	(0.0222)
Diff in Inangible Asset			0.0792			6.764
			(0.233)			(13.75)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	980	980	952	952	952
R^2	0.047	0.047	0.047	0.058	0.058	0.059
Adjusted R^2	-0.010	-0.012	-0.013	0.000	-0.002	-0.003

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Notes: Δ ln(Capacity) and Δ ln(Line Distance) represent the first differences of the firm's electricity generating capacity and the firm's length of transmission line, respectively. Other Controls include a constant term, year and prefecture-level service area fixed effects, and a dummy variable indicating whether the firm has other types of business outside the electric utility industry.

Table B1: Determinants of Mergers with Subgroup of Firms

	(i)	(ii)	(iii)	(iv)
Dependent Var.	Merger Dum.	Merger Dum.	Merger Dum.	Merger Dum.
ln(Acq. Capacity)	0.045	-0.115*	-0.115	-0.096
	(0.034)	(0.068)	(0.079)	(0.091)
ln(Tar. Capacity)	0.031	-0.334***	-0.325**	-0.371***
	(0.028)	(0.100)	(0.129)	(0.138)
ln(Acq. Line Dist.)	0.193***	0.220**	0.216**	0.220**
	(0.049)	(0.087)	(0.104)	(0.106)
ln(Tar. Line Dist.)	-0.031	-0.067	-0.088	-0.061
	(0.036)	(0.108)	(0.153)	(0.156)
ln(Acq. Capacity)		0.039***	0.026	0.043*
× ln(Tar. Capacity)		(0.011)	(0.019)	(0.023)
ln(Acq. Line Dist.)		0.010	-0.013	-0.003
× ln(Tar. Line Dist.)		(0.016)	(0.033)	(0.035)
Overlap Fraction		4.357***	4.372***	4.386***
		(0.346)	(0.348)	(0.352)
ln(Acq. Capacity)			0.020	0.007
× ln(Tar. Line Dist.)			(0.024)	(0.026)
ln(Acq. Line Dist.)			0.017	0.005
× ln(Tar. Capacity)			(0.026)	(0.028)
Acq. Frac. of BC				-0.388
				(0.355)
Tar. Frac. of BC				0.232
				(0.384)
Acq. Frac. of BC				-1.160
× Tar. Frac. of BC				(0.836)
Other Controls	Yes	Yes	Yes	Yes
Observations	18,768	18,768	18,768	18,570
Pseudo R^2	0.191	0.310	0.310	0.313

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Note: The dependent variable, Merger Dum., is merger dummy for all specification. ln(Acq. Capacity), ln(Tar. Capacity), ln(Acq. Line Dist.), ln(Tar. Line Dist.), Acq. Frac. of BC and Tar. Frac. of BC represent the logarithm of acquirers' capacity, the logarithm of target's capacity, the logarithm of acquirers' length of transmission line, the logarithm of target's length of transmission line, the acquirer's revenue share of business customers, and the target's revenue share of business customers, respectively. Other Controls includes a constant term, year fixed effects, prefecture-level service area fixed effects and a dummy variable whether the firm has other type of business outside the electric utility industry.