

Compatible Mergers: Assets, Service Areas and Market Power¹

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¹The analysis and conclusions set forth are those of the authors and do not indicate concurrence by other members of the staff, by the Board of Governors, or by the Federal Reserve Banks.

Why do firms merge?

- ▶ Why do firms merge? / How do mergers create value?
 - ▶ Finance/Management
 - ▶ Industrial Organization
- ▶ Huge attention is separately paid to:
 1. determinants of mergers
 2. consequences of mergers
 - ▶ stock prices, profitability and investment
 - ▶ prices and marginal costs (market power)

due to (i) data limitations and (ii) merger approvals

- ▶ Understanding relationships between determinants and consequences of mergers is essential for policy design:
 - ▶ Bailouts/Relief mergers
 - ▶ Merger approvals in competition policy

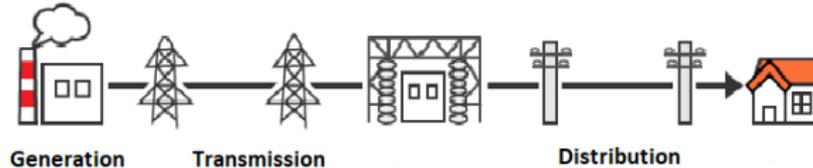
Research Questions

- ▶ We salvage the data on the pre-WWII Japanese electricity industry:
 1. the merger waves in a given industry
 2. the absence of anti-trust authority
 3. availability of the detailed data (firm- and plant-level)
- and bridge the gap in the literature by attempting to
- ▶ identify the determinants of mergers
 - ▶ examine how these determinants are translated into their production costs, pricing, production quantity and asset utilization.

Background and Data

How the Electricity Market Works

- ▶ Electricity is non-storable goods; Supply should be equal to demand
- ▶ The electricity industry consists of three parts:



1. Generation

2. Transmission

3. Distribution

- ▶ Business customers (Denryoku) – Daytime
- ▶ Retail customers (Dento) – Nighttime

Data (1/3): Data Sources

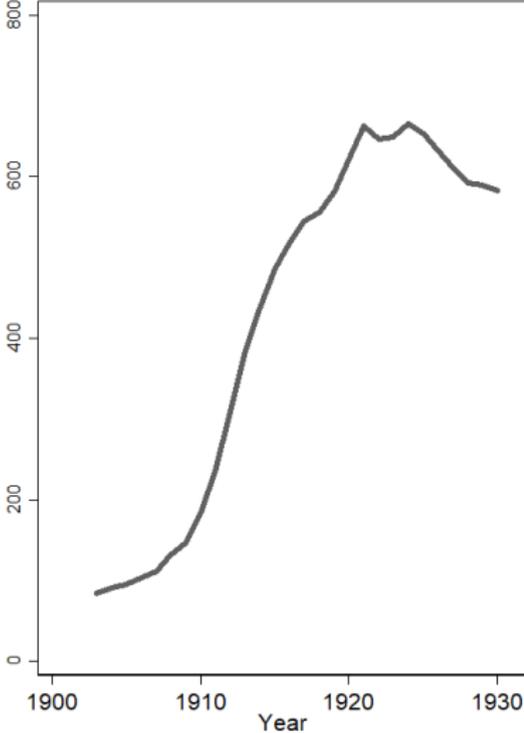
- ▶ Handbook of Electric Utility Industry (Denki Jigyo Yoran)
 - ▶ edited by the Ministry of Communications
 - ▶ annually published, but we use 1914, 1918, 1922, 1926 and 1930
- ▶ We focus on this particular period because
 - ▶ technological innovation allowed firms to transmit electricity efficiently
 - ▶ Thermal (coal) was dominant – located in city area
 - ▶ Water power plants became dominant around 1910
 - ▶ price should have been approved by the government since 1932

Data (3/3): Contained Information

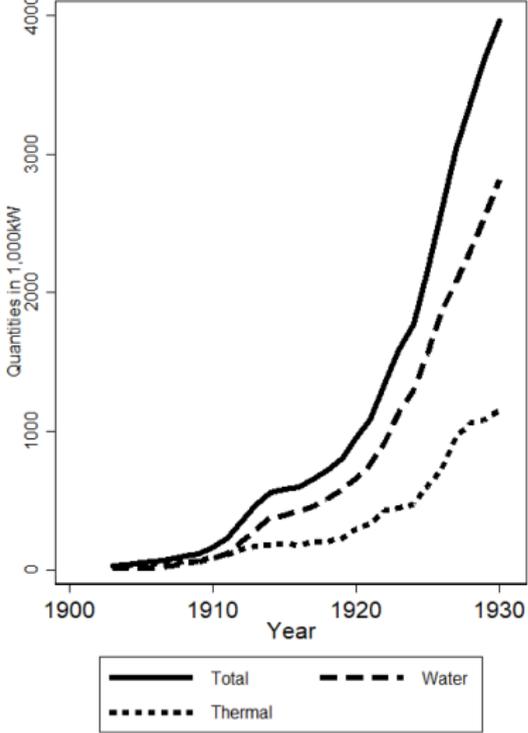
- ▶ Plant-level
 - ▶ Capacity (kW)
 - ▶ Output (MWh)
 - ▶ Location
- ▶ Firm-level
 - ▶ Service area, Roughly 700-800 counties:
 - ▶ Total transmission line distance (km)
 - ▶ Revenue from business- and retail-customers (in JPY)
 - ▶ Costs for electricity generation and line maintenance (in JPY)
 - ▶ Financial statement
- ▶ Merger information

Evolution of the Industry (1/2)

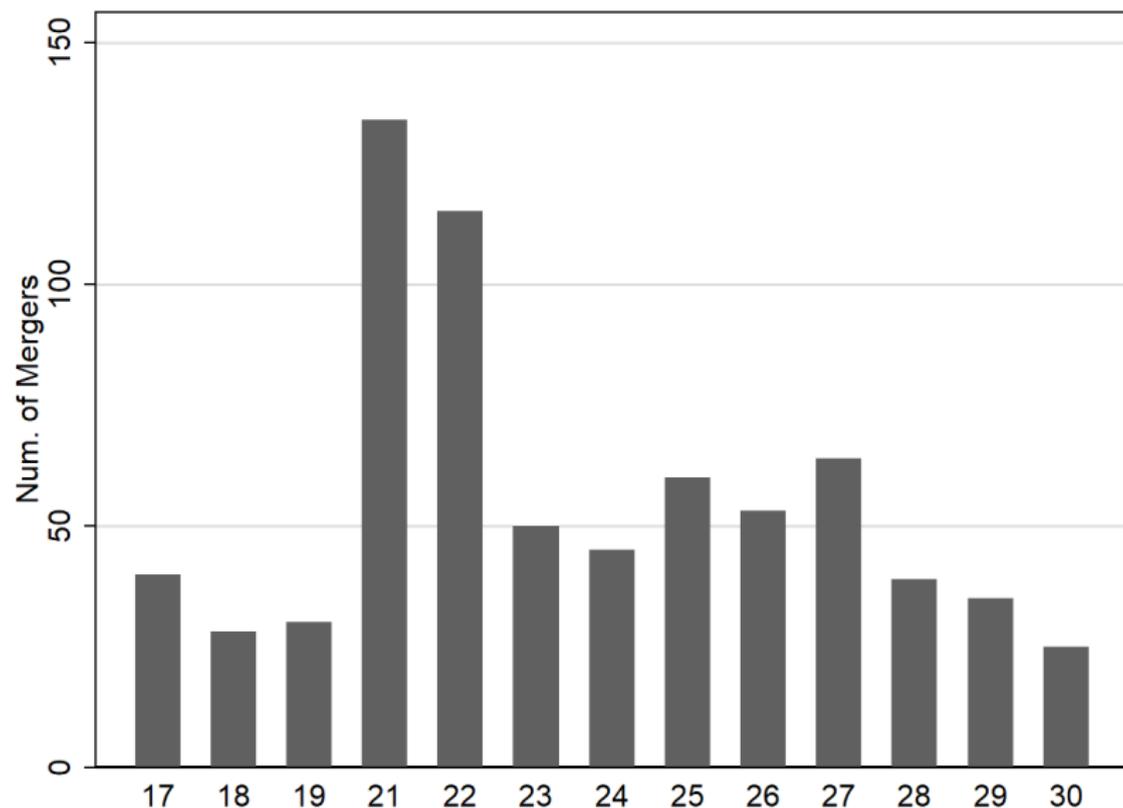
(a) Number of Electric Utility Firms



(b) Electricity Generation Capacity



Evolution of the Industry (2/2): Number of M&As



Descriptive Statistics (1/2): Firms' Characteristics

	1918		1922		1926		1930	
	mean	sd	mean	sd	mean	sd	mean	sd
National-level variables								
# of Firms	276		205		391		368	
Firm-level variables								
Capacity	2,370	7,832	4,068	10,913	5,889	25,647	9,958	46,055
Distance	132	210	265	424	303	1,101	621	2,320
# of Plants	1.98	1.70	2.46	2.49	2.64	4.98	3.09	5.77
Output	11,881	37,386	17,885	49,318	21,425	91,213	32,699	127,246
Electricity Cost	232	769	613	2,086	609	3,844	966	5,265
Rev. from RC	230	747	492	1,624	501	2,610	685	3,702
Rev. from BC	173	603	427	1,505	556	2,857	802	3,860
# of Business Area	3.71	4.45	4.42	5.93	3.54	8.29	3.86	9.55
Market-level variables								
# of Firms	2.31	1.53	2.69	1.83	2.92	2.10	2.53	1.79

Descriptive Statistics (2/2): Merger Characteristics

	1918		1922		1926		1930	
	mean	sd	mean	sd	mean	sd	mean	sd
National-level								
# of Mergers	25		232		157		142	
Acquirers								
# 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
Targets								
# 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

Empirical Analysis

Merger Determinants (1/6): Our Hypotheses

1. Do firms tend to acquire firms that have overlap in operating markets?
 - ▶ Pointed out by Akkus et al. (2016)
2. Do firms tend to acquire firms that have different types of assets?
 - ▶ Some recent examples:
 - ▶ Large tech companies buying small start-ups (finance/technology)
 - ▶ Global firms buy local firms (products/customers)
 - ▶ In our context, firms are heterogeneous in
 - ▶ physical asset compositions (Generation/Distribution)
 - ▶ type of reachable customers (Daytime/Nighttime)

Merger Determinants (2/6): Econometric Specification

- ▶ Estimate the following Probit model:

$$D_{ijt} = \begin{cases} 1, & \text{if } V_{ijt} \geq 0, \\ 0, & \text{if } V_{ijt} < 0, \end{cases} \quad \text{with}$$

$$V_{ijt} = \beta_0 + \beta_1 x_{it} + \beta_2 x_{jt} + \beta_3 x_{ijt} + \varepsilon_{ijt}$$

where

- ▶ D_{ijt} : A dummy variable for an observed merger between i and j at t
- ▶ V_{ijt} : Value of a merged firm
- ▶ x_{it} : Acquirer characteristics
- ▶ x_{jt} : Target characteristics
- ▶ x_{ijt} : Interaction btw x_{it} and x_{jt}
- ▶ We use the following variables as x_{it} , x_{jt} , and x_{ijt} :
 - ▶ Capacity
 - ▶ Distance of transmission line
 - ▶ Fraction of overlapping business area

Merger Determinants (3/6): An Example

- ▶ A simple example:

$$V_{ij} = \beta_0 + \beta_1 C_i + \beta_2 C_j + \beta_3 D_i + \beta_4 D_j + \beta_5 C_i C_j + \beta_6 D_i D_j + \beta_7 C_i D_j + \beta_8 C_j D_i$$

- ▶ $\frac{\partial V_{ij}}{\partial C_i} = \beta_1 + \beta_5 C_j + \beta_7 D_j$
- ▶ We expect $\beta_5 < 0$ and $\beta_7 > 0$

Merger Determinants (4/6): Estimation Results

	(1) Merger Dum.	(2) Merger Dum.	(3) Merger Dum.
ln(Acq. Capacity)	0.070** (0.033)	0.434** (0.166)	0.386** (0.179)
ln(Acq. Line Dist.)	0.211** (0.048)	0.118 (0.073)	0.196** (0.097)
ln(Tar. Capacity)	0.029 (0.028)	0.017 (0.030)	-0.256** (0.118)
Overlap Fraction		3.974*** (0.326)	3.949*** (0.334)
ln(Acq. Capacity) × ln(Tar. Capacity)		-0.022** (0.011)	-0.028** (0.012)
ln(Acq. Line Dist.) × ln(Tar. Line Dist.)		0.035** (0.013)	-0.055** (0.027)
ln(Acq. Capacity) × ln(Tar. Line Dist.)			0.049** (0.016)
ln(Acq. Line Dist.) × ln(Tar. Capacity)			0.045** (0.018)
Other Controls	Yes	Yes	Yes
Observations	36858	36858	36491

Merger Determinants (5/6): Comparison with Book Value

	(3) Merger Dum.	(4) Merger Dum.
ln(Acq. Book Asset)	-	0.091 (0.083)
ln(Tar. Book Asset)	-	-0.472*** (0.106)
ln(Acq. Book Asset) × ln(Tar. Book Asset)	-	0.030*** (0.007)
Overlap Fraction	3.949*** (0.334)	3.067*** (0.218)
ln(Acq. Capacity) × ln(Tar. Capacity)	-0.028** (0.012)	-
ln(Acq. Line Dist.) × ln(Tar. Line Dist.)	-0.055** (0.027)	-
ln(Acq. Capacity) × ln(Tar. Line Dist.)	0.049** (0.016)	-
ln(Acq. Line Dist.) × ln(Tar. Capacity)	0.045** (0.018)	-
Other Controls	Yes	Yes
Observations	36491	65571

Merger Determinants (6/6): Summary of Our Findings

- ▶ Positive assortative matching?
 - ▶ Yes, when using the book value of asset.
 - ▶ No positive assortative patterns after controlling for asset types and interactions.
- ▶ Larger (smaller) firms tend to be acquirers (targets)
- ▶ Firms are more likely to merge when
 - ▶ their (geographical) service areas are overlapped
 - ▶ there are larger differences in asset composition (Capacity/Line)
- ▶ How these determinants affect post merger behaviors?

Post-Merger Analysis (1/7): Econometric Specification

- ▶ We employ the following DiD-like specification:

$$\Delta \ln y_{it} = \alpha + \phi D_{it} + \mu M_{it} + \beta \Delta \ln X_{it} + \epsilon_{it},$$

where

- ▶ $\Delta \ln y_{it}$: Unit costs, average prices, total production, and asset utilization
- ▶ D_{it} : A dummy that indicates mergers in the last period
- ▶ M_{it} : Merger characteristics:
 - ▶ Tangible (generation/line) asset composition
 - ▶ Intangible (business/retail) customer composition
 - ▶ A fraction of overlapping service areas between i and merged firms
- ▶ $\Delta \ln X_{it}$: Differences in other controls

Post-Merger Analysis (2/7): Unit Costs

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \log \text{UC}$					
Merger Dum.	-0.0165 (0.128)	0.0913 (0.173)	0.254 (0.181)	-0.0908 (0.118)	0.0468 (0.158)	0.224 (0.165)
Overlap Frac.		-0.0267 (0.115)	-0.0415 (0.114)		-0.0556 (0.105)	-0.0722 (0.104)
Diff in Tang. A.		-0.315*** (0.0739)	-0.255*** (0.0762)		-0.317*** (0.0674)	-0.251*** (0.0694)
Diff in Intang. A.			-0.235*** (0.0797)			-0.257*** (0.0727)
$\Delta \log(\text{Capacity})$				-0.518*** (0.0487)	-0.519*** (0.0480)	-0.521*** (0.0477)
$\Delta \log(\text{Line Dist.})$				0.00460 (0.0670)	0.00404 (0.0661)	0.0127 (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

Post-Merger Analysis (2/7): Unit Costs

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \log \text{UC}$					
Merger Dum.	-0.0165 (0.128)	0.0913 (0.173)	0.254 (0.181)	-0.0908 (0.118)	0.0468 (0.158)	0.224 (0.165)
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Observations	776	776	776	766	766	766
Adjusted R^2	0.077	0.097	0.107	0.207	0.229	0.242

Post-Merger Analysis (3/7): Average Prices

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \log(p)$	$\Delta \log(p)$	$\Delta \log(p)$	$\Delta \log(p)$	$\Delta \log(p)$	$\Delta \log(p)$
$\Delta \text{Avg \# of Firms}_t$	0.00688 (0.0257)	-0.00653 (0.0254)	-0.00770 (0.0253)	0.0104 (0.0227)	-0.00363 (0.0223)	-0.00503 (0.0221)
Merger Dum.	-0.0112 (0.104)	0.150 (0.141)	0.286* (0.146)	-0.0716 (0.0912)	0.120 (0.123)	0.277** (0.127)
Overlap Frac.		-0.0851 (0.0916)	-0.0968 (0.0911)		-0.114 (0.0798)	-0.128 (0.0789)
Diff in Tang. A.		-0.283*** (0.0584)	-0.231*** (0.0603)		-0.287*** (0.0509)	-0.227*** (0.0522)
Diff in Intang. A.			-0.203*** (0.0633)			-0.234*** (0.0549)
$\Delta \log(\text{Capacity})$				-0.468*** (0.0372)	-0.470*** (0.0363)	-0.472*** (0.0359)
$\Delta \log(\text{Line Dist.})$				0.115** (0.0522)	0.119** (0.0510)	0.127** (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

Post-Merger Analysis (3/7): Average Prices

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \log(p)$	$\Delta \log(p)$	$\Delta \log(p)$	$\Delta \log(p)$	$\Delta \log(p)$	$\Delta \log(p)$
$\Delta \text{Avg \# of Firms}_t$	0.00688 (0.0257)	-0.00653 (0.0254)	-0.00770 (0.0253)	0.0104 (0.0227)	-0.00363 (0.0223)	-0.00503 (0.0221)
Merger Dum.	-0.0112 (0.104)	0.150 (0.141)	0.286* (0.146)	-0.0716 (0.0912)	0.120 (0.123)	0.277** (0.127)
Overlap Frac.		-0.0851 (0.0916)	-0.0968 (0.0911)		-0.114 (0.0798)	-0.128 (0.0789)
Diff in Tang. A.		-0.283*** (0.0584)	-0.231*** (0.0603)		-0.287*** (0.0509)	-0.227*** (0.0522)
Diff in Intang. A.			-0.203*** (0.0633)			-0.234*** (0.0549)
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$\Delta \log(\text{Line Dist.})$				0.115** (0.0522)	0.119** (0.0510)	0.127** (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

Post-Merger Analysis (4/7): Cost Pass-Through

	(1)	(2)	(3)	(4)
	$\Delta \log \text{UC}$	$\Delta \log(p)$	$\Delta \log \text{UC}$	$\Delta \log(p)$
$\Delta \text{Avg \# of Firms}_t$	-	-0.00770	-	-0.00503
	-	(0.0254)	-	(0.0221)
Merger Dummy	0.254	0.286*	0.224	0.277**
	(0.1814)	(0.141)	(0.165)	(0.127)
Overlap Fraction	-0.0415	-0.0968	-0.0722	-0.128
	(0.114)	(0.0911)	(0.1045)	(0.0789)
Diff in Tangible Asset	-0.255***	-0.231***	-0.251***	-0.227***
		(0.0603)	(0.0694)	(0.0522)
Diff in Intangible Asset	-0.235***	-0.203***	-0.257***	-0.234***
	(0.0797)	(0.0633)	(0.0727)	(0.0549)
$\Delta \log(\text{Capacity})$			-0.521***	-0.472***
			(0.0477)	(0.0359)
$\Delta \log(\text{Line Distance})$			0.0127	0.127**
			(0.0656)	(0.0504)
Other Controls	Yes	Yes	Yes	Yes
Observations	776	756	766	743
Adjusted R^2	0.107	0.137	0.229	0.324

Post-Merger Analysis (5/7): Total Production

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \log \text{ Out}$					
Merger Dum.	0.0635 (0.127)	-0.0484 (0.172)	-0.203 (0.180)	0.177* (0.104)	0.0403 (0.140)	-0.128 (0.146)
Overlap Frac.		0.0380 (0.114)	0.0521 (0.114)		0.0610 (0.0924)	0.0768 (0.0917)
Diff in Tang A.		0.285*** (0.0735)	0.228*** (0.0759)		0.292*** (0.0596)	0.230*** (0.0613)
Diff in Intang. A.			0.223*** (0.0794)			0.244*** (0.0642)
$\Delta \log(\text{Capacity})$				0.591*** (0.0431)	0.592*** (0.0424)	0.594*** (0.0420)
$\Delta \log(\text{Line Dist.})$				0.335*** (0.0587)	0.336*** (0.0578)	0.328*** (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

Post-Merger Analysis (6/7): Capacity Utilization

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \log \text{Utl}$					
Merger Dummy	0.171 (0.111)	0.00389 (0.150)	-0.172 (0.157)	0.177* (0.104)	0.0403 (0.140)	-0.128 (0.146)
Overlap Frac.		0.0908 (0.0995)	0.107 (0.0988)		0.0610 (0.0924)	0.0768 (0.0917)
Diff in Tang. A.		0.289*** (0.0642)	0.225*** (0.0660)		0.292*** (0.0596)	0.230*** (0.0613)
Diff in Intang. A.			0.253*** (0.0690)			0.244*** (0.0642)
$\Delta \log(\text{Capacity})$				-0.409*** (0.0431)	-0.408*** (0.0424)	-0.406*** (0.0420)
$\Delta \log(\text{Line Dist.})$				0.335*** (0.0587)	0.336*** (0.0578)	0.328*** (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

Post-Merger Analysis (7/7): Line Utilization

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \log \text{Utl}$					
Merger Dummy	0.165 (0.121)	0.0672 (0.163)	-0.0790 (0.171)	0.177* (0.104)	0.0403 (0.140)	-0.128 (0.146)
Overlap Frac.		0.0227 (0.108)	0.0363 (0.107)		0.0610 (0.0924)	0.0768 (0.0917)
Diff in Tang. A.		0.294*** (0.0695)	0.240*** (0.0718)		0.292*** (0.0596)	0.230*** (0.0613)
Diff in Intang. A.			0.213*** (0.0752)			0.244*** (0.0642)
$\Delta \log(\text{Capacity})$				0.591*** (0.0431)	0.592*** (0.0424)	0.594*** (0.0420)
$\Delta \log(\text{Line Dist.})$				-0.665*** (0.0587)	-0.664*** (0.0578)	-0.672*** (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

Conclusion

- ▶ Determinants of mergers: Firms are more likely to merge when...
 - ▶ there are larger differences in tangible asset composition (G/T)
 - ▶ there are a lot of overlaps in their operating markets
- ▶ Consequences of mergers
 1. **Production costs** decrease when
 - ▶ there are larger differences in tangible and intangible asset compositions
 - Tangible: Generation/Transmission
 - Intangible: (Business Customers)/(Retail Customers)
 2. **Electricity prices** increase when firms merge
 - ▶ Cost reduction is passed through to the prices, but not perfectly.
 - ▶ On average, the price does not increase
- ▶ Policy Implications
 - ▶ There are mergers that only benefit firms and that Pareto improve both firms and consumers.
 - ▶ A role played by antitrust authorities may be important.

Related Literature

▶ Merger Determinants

- Akkus, Cookson and Hortacsu (2016, MS)
- Uetake and Watanabe (2017)

Reduced form profit function and silent about why firms merge
(e.g. if they aim for cost efficiency or market power)

▶ Post-Merger Outcomes

- ▶ Survey: Ashenfelter et al (2014, JLE)
 - ▶ Generally, people find increases in prices
 - ▶ Little evidence on the source of cost efficiency
 - Reallocation of production: Ashenfelter et al (2014, Rand)
- ▶ The banking industry is an exception
 - ▶ US: Akkus, Cookson and Hortacsu (2016, MS) etc..
 - ▶ Italian: Focarelli and Panetta (2003, AER)
- ▶ What variations are used?
 - ▶ Geographical variations: Ashenfelter et al (2014, Rand) and Allen et al (2014, AER)
 - ▶ Variations in product lines (Ohashi and Toyama, 2017, JIE)