Cost of Capital and Productivity: An Analysis of Cooperative and For-Profit Firms in the U.S. Electric Power Industry

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Section 1

Motivation and Research Question

Motivation

- This paper has two objectives:
  - Analyze financial performances of cooperatives relative to for-profit firms in the electric power industry
  - Investigate the sources of performance differences under a model of cost minimization.
- The literature provides mixed results.
  - Hollas and Stansell (1988), Rose and Joskow (1990)
  - Atkinson and Halvorsen (1986)
  - Koh et al. (1996), Pescatrice and Trapani (1980)

Motivation

- Why would ownership structure affect firm performances?
- Two characteristics of cooperatives distinct from those of for-profit firms:
  - Ownership by members beyond that of investors.
  - Democratic governance.
- Results in different incentives for firm behaviors.
  - Services provided at below/above profit-maximizing rates.
  - Community development activities.
  - Increased or decreased cost of monitoring firm performances.

Ownership structure in the electric power industry

1. Investor-owned utilities (IOUs)
   - Traditionally dominant electricity providers (above 70%).
2. Independent power producers (IPPs)
   - Developed recently by PURPA of 1978.
     - IOUs were required to buy electricity from IPPs at avoided costs.
   - Grown fast during the industry restructuring periods in 1990s.
   - In 2013, IOUs and IPPs accounted for about 39% and 40% of electricity generation.
3. Cooperatives
   - Established since 1930s under REA to offer an alternative to IOUs in rural areas.
   - Generation and Transmission (G&Ts) or distribution only.
   - 5% of generation covering 70% of the nation's landmass.
4. Government-owned utilities

Ownership structure and regulation

- Virtually all firms operate subject to some forms of regulation regardless of ownership.
  - E.g., siting of power plants, renewable energy portfolios, and safety requirements.
- Many IOUs are subject to the form of cost-of-service regulation.
  - Guaranteed recovery of operating expenses and regulated rate-of-return on investments.
  - Restructured vs non-restructured states.
- IPPs rely on the market competition to provide revenue streams in return for investments.
- Cooperatives are generally free from regulation.
  - 14 states have regulatory jurisdiction over the rates that cooperatives charge their members.

Tentative results

- IOUs are more profitable.
  - Higher returns on assets and equity.
  - Lower cost of capital.
  - Higher markup.
- No significant differences in physical productivity between IOUs and cooperatives.
- IOUs tend to over-invest in capital under the cost-of-service regulation (Averch and Johnson 1962).
- IPPs are more profitable and productive than their counterparts.
  - Lower cost of debt is partly offset by higher cost of equity resulting in higher cost of capital than IOUs.

Section 2

Data and Descriptive Statistics

Data

- Two sources of data:
    - Annual firm data for major electric utilities (FERC Form 1).
    - Annual plant data for existing generating plants (EIA 860).
- Aggregate plant-level data and match with Form 1 by the firms that own the plants to use a firm-year observation.
- The constructed dataset consists of 113 firms or 1123 observations from 2001 and 2013.
    - 10 (84) G&T cooperatives, 101 (1022) IOUs, and 2 (17) IPPs.
- Unbalanced panel due to missing observations.

Table 1: Firm performances by ownership

Ownership type	Cooperative	IOU	IPP
Total Assets ($ mil)	692	6460	853
	(491)	(7930)	(906)
Shareholder Equity ($ mil)	156	2043	174
	(100)	(2508)	(175)
Long-term Debt ($ mil)	400	1802	384
	(286)	(2079)	(318)
Operating Revenue ($ mil)	358	2266	497
	(248)	(2580)	(327)
Electric Revenue ($ mil)	352	2026	497
	(254)	(2303)	(327)
Operating Expense ($ mil)	305	1246	332
	(223)	(1518)	(186)
Interest Charges ($ mil)	24	106	31
	(16)	(128)	(39)
Dividends ($ mil)	0	120	37
	(0)	(184)	(49)
Net Income (before tax, $ mil)	33	931	136
	(19)	(1256)	(128)
Net Income (after tax, $ mil)	30	388	77
	(18)	(513)	(67)
Number of Firms	10	101	2
Number of Observations	84	1022	17

Table 1: Firm performances by ownership (cont.)

Ownership type	Cooperative	IOU	IPP
Shareholder Equity Ratio	0.26	0.32	0.26
	(0.12)	(0.08)	(0.15)
Profit ($ mil)	29	793	97
	(19)	(1122)	(99)
Return on Assets (before tax)	0.06	0.15	0.27
	(0.03)	(0.06)	(0.37)
Return on Assets (after tax)	0.04	0.12	0.15
	(0.03)	(0.06)	(0.15)
Return on Equity (before tax)	0.24	0.54	1.64
	(0.12)	(0.58)	(2.29)
Return on Equity (after tax)	0.21	0.23	1.05
	(0.11)	(0.29)	(1.50)
Weighted Average Cost of Capital	0.03	0.02	0.12
	(0.02)	(0.01)	(0.19)
Cost of Debt	0.04	0.02	0.03
	(0.01)	(0.009)	(0.02)
Long-term Debt to Equity	2.57	1.74	2.29
	(1.31)	(8.21)	(3.54)
Total Electricity Output/Total Assets (Mwh/$)	0.009	0.005	0.03
	(0.004)	(0.003)	(0.01)
Number of Firms	10	101	2
Number of Observations	84	1022	17

Descriptive statistics

- The weighted average cost of capital (WACC) is calculated as

$$WACC = \frac{E}{A}D + \frac{L}{A}I(1-t) \tag{1}$$

  - E is shareholder equity,
  - A total assets,
  - D dividends,
  - L debt,
  - I interest charges, and
  - t tax rate.

Table 2: Firm control variables by ownership

Ownership type	Cooperative	IOU	IPP
Total Electricity Output (mil Mwh)	5.8	25.7	14.5
	(4.1)	(17.3)	(8.0)
Purchased Electricity (mil Mwh)	3.5	8.5	4.3
	(3.1)	(10.4)	(4.8)
Steam Turbine (Mw)	78	2654	1766
	(181)	(3162)	(930)
Combustion Turbine (Mw)	245	580	464
	(181)	(905)	(675)
Internal Combustion (Mw)	17.70	7.64	1.05
	(27.73)	(18.37)	(1.47)
Combined Cycle (Mw)	58.58	537	204
	(113)	(1412)	(300)
Other (Mw)	4.04	326.74	0
	(10.72)	(725.34)	(0)
Urban-Rural Indicator	2.14	1.86	3.58
	(1.87)	(1.90)	(1.97)
Number of Firms	10	101	2
Number of Observations	84	1022	17

Notes: Standard deviations are in parentheses.

Section 3

Preliminary Analysis

Table 3: Firm performances estimates

$$y_{ist} = \alpha + \beta FirmType_i + X_{ist}\gamma + \lambda_s + \delta_t + \epsilon_{ist} \qquad (2)$$

Table 3: Firm Performances Estimates

Coefficient on	Dependent Variable							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ROA-A	ROA-B	ROE-A	ROE-B	WACC	COD	DE	OA
IOU	0.13*	0.63**	-0.15	0.37**	-0.53**	-0.71**	-0.65**	-0.41**
	(0.07)	(0.09)	(0.13)	(0.13)	(0.12)	(0.07)	(0.14)	(0.08)
IPP	0.71**	1.18**	1.09**	1.55**	0.15	-0.68**	-0.06	1.05**
	(0.21)	(0.21)	(0.27)	(0.26)	(0.33)	(0.22)	(0.32)	(0.19)
Firm Controls (X_{ist})	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.36	0.51	0.43	0.48	0.33	0.42	0.45	0.75

Notes: Standard errors are in parentheses.

** Significant at 5 percent or stricter

* Significant at 10 percent

Section 4

Empirical Model

A model of cost minimization

- Investigate the sources of the performance differences.
  - One potential source is the productivity, which measures the cost differences to produce the same amount of electricity.
- Firms minimize the cost of production regardless of their ownership structure.
  - Different ownership structures may have different objectives to maximize.
- Gandhi et al.(2013) provides a framework to estimate the markup and productivity.

Section 5

Results

First-stage estimation results

Markup IOU	0.37**
	(0.05)
Markup IPP	0.14
	(0.12)
Cost elasticity of output	1.27**
	(0.008)

Notes: Standard errors are in parentheses.
** Significant at 5 percent or stricter
* Significant at 10 percent

Second-stage estimation results

Natural Gas Price	0.72**
	(0.21)
Coal Price	0.37**
	(0.13)
Purchased Price	0.14
	(0.17)
Steam Turbine	-0.25**
	(0.05)
Combustion Turbine	0.004
	(0.03)
Internal Combustion	0.05**
	(0.003)
Combined Cycle	0.01
	(0.02)
Other	-0.03
	(0.03)

Notes: Standard errors are in parentheses.
** Significant at 5 percent or stricter
* Significant at 10 percent

Figure 1: Productivity estimates
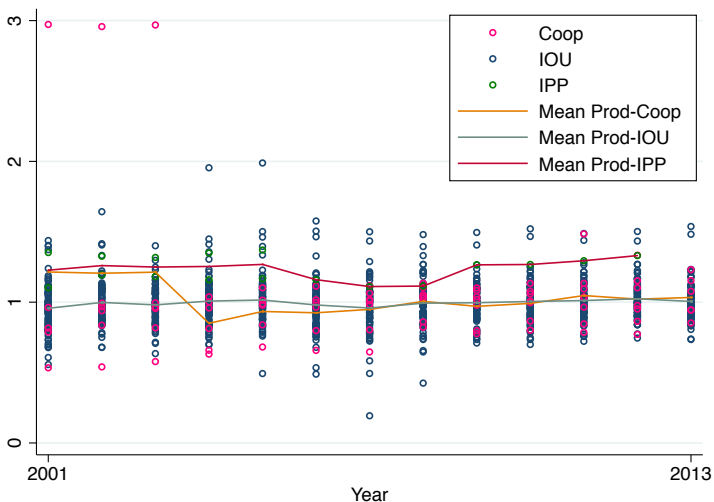
Future works

- Learning about vertical relationships between G&T and member distribution cooperatives.
  - Data on distribution cooperatives from RUS over 2006-2011.
  - Compare with IOUs.
    - Surplus distribution along the vertical chain.
    - Efficiency improvement (or not) through the vertical channel.
  - Incorporate "geographic demand characteristics."
    - E.g., most distribution cooperatives are in rural areas.