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Summary of Econometric Power Transmission Cost Studies

Agrell, P., & Bogetoft, P. (2009), International Benchmarking of Electricity Transmission System Operators: e3 GRID Project—Final Report, Brussels: Sumicsid Group.

- This report presents the results of benchmarking studies for 22 transmission system operators in Europe from 2003-2006. The study was conducted for the Council of European Energy Regulators (CEER).
- The benchmarking analysis focused on construction, maintenance, planning and administration/support activities. It excludes market facilitation, system operations and grid finance.
- The recommended benchmarking approach is data envelopment analysis (DEA), but results for econometric modelling using stochastic frontier analysis (SFA) and corrected ordinary least squares (COLS) are presented in a supplementary fashion, and largely agree with the DEA results. Several cost drivers were examined. The main focus is on total expenditures and not total cost.

Dismukes, D. E., Cope, R. F., III, & Mesyanzhinov, D. (1998). Capacity and economies of scale in electric power transmission. *Utilities Policy*, *7*(3), 155-162.

- The authors present an econometric cost model of translog form for electric transmission. Data are for large investor owned utilities in the U.S. from 1986-1991.
- Among other variables, they include the region of operation, transmission system power flows, wage costs, transmission line mileage distances, and transformer capacity.

Getachew, L., & Lowry, M. N. (2009). The economics and regulation of power transmission and distribution: The developed world case. In Evans, J., & Hunt, L. C. (Eds.), *International handbook on the economics of energy* (pp. 499-540), Northhampton: Edward Elgar.

- This study examined the cost structure of U.S. electric transmission companies. Data for 43 investor-owned electric utilities between 1998-2000 were drawn from the FERC Form 1 and other sources.
- The analysis employed a translog model of total cost, which is estimated using iterative feasible generalized least squares (FGLS). The outputs modeled are delivery volume and kV circuit miles, and a number of other explanatory variables are also included.
- The authors report the sample mean elasticities of cost with respect to both outputs.

Greenfield, D., & Kwoka, J. (2011). The cost structure of regional transmission organizations. *The Energy Journal*, *32*(4), 159-181.

- These authors study the cost drivers of the 7 regional transmission organizations (RTOs) in the U.S. from 1998-2008. It does not focus on electric transmission costs overall, but rather on the market functions of RTOs.
- A Cobb-Douglas total cost function was estimated, with panel-specific autocorrelation and heteroskedasticity corrections. Econometric results are presented, and also used to estimate the cost of some 'hypothetical' RTOs.

Haney, A. B., & Pollitt, M. G. (2009). Efficiency analysis of energy networks: An international survey of regulators. *Energy Policy*, *37*(12), 5814-5830.

- The authors present the results of a survey of 43 regulators in 40 countries.
- The technique used in each country for benchmarking of electricity transmission is shown (e.g., data envelopment analysis [DEA], econometric modelling using stochastic frontier analysis [SFA], corrected ordinary least squares [COLS], and process/activity benchmarking). The authors also include data on what is benchmarked (e.g., total expenditures, operating expenses), and whether the data used are a panel and/or are international in scope.
- This paper does not present the econometric results themselves nor discuss weights.

Haney, A. B., & Pollitt, M. G. (2013). International benchmarking of electricity transmission by regulators: A contrast between theory and practice? *Energy Policy*, *62*, 267-281.

- The authors present the results of a survey of 25 national energy regulators.
- The technique used in each country for benchmarking of electricity transmission is shown, as is what is benchmarked (e.g., total expenditures, operating expenses) and whether the data used are a panel and/or are international in scope. The authors also discuss whether environmental variables were included and present some information on output measures.

Huettner, D. A., & Landon, J. H. (1978). Electric utilities: Scale economies and diseconomies. *Southern Economic Journal, 44*(4), 883-912.

- This study presents regression results separately for generation, transmission, distribution and other cost categories. The sample used is 1971 data for 74 U.S. vertically integrated electric utilities.
- The authors' objective is to test for the presence of economies of scale.
- They do not find evidence for economies of scale in transmission (this may be because they use generating capacity as their proxy of firm size).

Lawrence, D., Coelli, T., & Kain, J. (2014). Economic benchmarking assessment of operating expenditure for NSW and Tasmanian electricity TNSPs, Eden: Economic Insights.

- This study evaluates productivity using operating-expense and multifactor productivity indexes.
- Weights for the output specification in the index are estimated via econometrics (primarily translog, though Leontief where necessary). The reliability output weight is obtained in a different fashion. Weights for the input specification are borrowed from an earlier Pacific Economics Group analysis.

Llorca, M., Orea, L., & Pollitt, M. G. (2013). Efficiency and environmental factors in the US transmission industry (Working Paper No. 1312), Energy Policy Research Group, University of Cambridge.

- The authors present an econometric stochastic frontier analysis (SFA) of 59 U.S. electricity transmission companies' total expenditures from 2001-2009. Data are from the FERC Form 1 and other sources.
- Outputs are peak load and electricity delivered; network length is also included but not considered an 'output.' The model also includes labor/capital price, capital additions and a time trend. The translog cost function uses demeaned data, so the first-order coefficients represent the elasticities at the sample mean.
- The model also predicts the determinants of the inefficiency scores: they examine weather variables, weather variables interacted with the ratio of capital expenditures to operating expenses, and positive and negative demand growth.

Llorca, M., Orea, L., & Pollitt, M. G. (2014). Using the latent class approach to cluster firms in benchmarking: An application to the US electricity transmission industry. *Operations Research Perspectives*, *1*(1), 6-17.

- The authors propose using a two-stage approach to benchmarking: first a latent class model (LCM), and then data envelopment analysis (DEA) (though other techniques could also be used for the second stage). The LCM stage uses operating characteristics/environmental factors to distinguish classes.
- They demonstrate the approach on a sample of 59 U.S. transmission companies. They use both a Cobb-Douglas and a translog functional form for the LCM.

Ofgem (2011). Decision on strategy for the next transmission price control - RIIO-T1 tools for cost assessment. London: Office of Gas and Electricity Markets.

- This document articulates plans to use econometric methods (corrected ordinary least squares [COLS] and stochastic frontier analysis [SFA]) to benchmark electricity transmission total expenditures. Some expected cost drivers are also identified.
- However, the results of these econometric analyses are not presented in this document.

Pérez-Arriaga, I. J., Montero, F. P., & Odériz, F. J. R. (2002). Benchmark of Electricity Transmission Tariffs (Final Report), Instituto de Investigación Tecnológica, Universidad Pontificia Comillas.

- This study was prepared for the Directorate-General for Energy and Transport/European Commission.
- The authors first use multivariate regression to look at the relationship between several explanatory variables and the normalized km of grid ("step 0-->1"), and then do another analysis to relate the km of grid to transmission costs ("step 1-->2"). They also do a third analysis that relates costs to tariff rates. They refer to the whole thing as a 'correlation analysis.'
- They include 17 European countries in step 0-->1, but only 10 in step 1-->2 due to lack of data. Also, the cost data are calculated in various ways that make them less comparable.

Pollitt, M. G. (1995). ***Ownership and performance in electric utilities: The international evidence on privatization and efficiency*****. New York: Oxford University Press, pp. 159-184.**

- The author estimates both data envelopment analysis (DEA) and ordinary least squares (OLS) models of transmission cost, using data for 129 U.S. electric utilities in 1990.
- In the OLS model, the dependent variable is O&M costs per million kWh. The capacity proxy (circuit km*kV) is logged, but neither the other independent variables nor the dependent variable are logged.
- He finds evidence for economies of scale, and other significant results. Significant coefficients are associated with capacity and its square, underground circuit km and its square, and the wage rate.