HAS THE UNBUNDLING REFORM IMPROVED SERVICE EFFICIENCY AND TECHNICAL EFFICIENCY OF CHINA'S POWER GRID COMPANIES?

Bai-Chen Xie, Tianjin University, Phone +86-13312188917, E-mail: xiebaichen@tju.edu.cn

Zhen-Jiang Zhang, Tianjin University, Phone +86-17695751114, E-mail: zhangzhenjiang6@tju.edu.cn

Overview

China's electric power transmission and distribution network are collectively referred to the grid, which is an inalienable part of the power system. It connects power plants with customers. With the rapid development of China's economy and industrialization, the development of the power grid sector has achieved remarkable success. Coupling with the changing power supply and demand situation in recent years, improving the service quality and power transmission efficiency of the power grid has become the most critical issue of grid companies.

Since 2002, China has introduced a market competition mechanism in the power system. With the implementation of the unbundling of generation sector and power grid, the power assets managed by the state power company are divided into two types of business: power generation and power grid. Ongoing reforms aim to separate power plants from power-supply networks, privatize a significant amount of state-owned property, encourage competition, and revamp pricing mechanisms. Separation of the main electricity business from auxiliary businesses was completed in 2011. At the end of 2011, China's installed capacity has reached 1.056 billion kilowatts, and the power generation has amounted to 4.70 TWh, which is about 2.8 times that of 2002.

The issue of power shortage in China has been successfully overcome after 2009 through the reform of the power system with the separation of power and network and supervision according to law. Although it has brought us a variety of benefits, due to regional economic development imbalance, terrain conditions, industrial structure differences, regional and structural power grid development differ significantly across regions. Therefore, there are many heterogeneity factors that affect the technical efficiency of the power grid sector during construction and operation. At present, there is still no research using efficiency evaluation method which can consider heterogeneity factors to prove that plant-grid separation does improve the technical efficiency of China's power grid sector. Therefore, this paper hopes to use stochastic frontier analysis(SFA)to evaluate the impact of the unbundling reform on China's power grid sector and to reveal the fact that whether the areas with low efficiency are influenced by heterogeneity.

Methods

In this section, we provide a brief introduction of the SFA method. Data Envelope Analysis(DEA) and SFA are the two most commonly used frontier analysis methods, each with its own characteristics. DEA is a non-parametric and deterministic programming model, which constructs a frontier in each period. Accordingly, SFA is a parametric and stochastic econometric model, which can separate non-efficiency terms from random factors.

However, due to regional economic development imbalance, terrain conditions, industrial structure differences, there are regional and structural power grid development imbalance in China.Which means there will be heterogeneity factors affecting the both service efficiency (SE) and technical efficiency (TE) in the process of power grid construction and operation. If these factors are not considered, the efficiency measurement results will be deviated. Therefore, SFA is more suitable for this kind of efficiency research which needs to consider the heterogeneity factors. Further more, we will analyse both SE and TE of power grid companies by comparing many years' data, so a panel data model is a necessity.

TE, which reflects economic benefits, become SE when service quality is included in outputs. In order to capture any inefficiencies, two groups of models are assumed: the approach which was brought by Kumbhakar(2014); the approach which was brought by Battese & Coelli(1992) (BC92 here after). We select the model which was brought by Kumbhakar in 2014 because the efficiency of power grid companies is not only affected by observable heterogeneity, the firm heterogeneity will also affect the efficiency. Not only that, the model

should also be able to take into account any fixed or random effects associated with unobserved factors that are not related to inefficiency. So our Model 1 is specified as:

$$y_{it} = \alpha_0 + f(x_{it};\beta) + \mu_i - \eta_i + v_{it} - u_{it} \quad (1)$$

where μ_i are random firm effects that capture unobserved time-invariant inputs.This model has foul components, two of which(η_i and u_{it}) are inefficiency and the other two are firm effects and noise(μ_i and v_{it}). These components appeared in other models in various combinations but not all at the same time in one model.

Estimation of this model can be done in a single stage ML method based on distributional assumptions on foul components(Colombi et al. 2011). We follow a simpler multi-step procedure(Kumbhakar et al. 2014), which can be estimated in three steps. In the first step we estimate a random -effects panel model, and save the error component, then it comes to the second step, residual efficiency will be estimated by us and in the end, the persistent efficiency will be estimated. And also, we will apply BC92 model to estimate whether environmental factors have an impact on the results. Since BC92 model won't be able to include environmental factors, we believe it's a good idea to use it as a comparison group.

Results

Overall, both TE and SE of power grid companies are lower before the unbundling. After the unbundling was promulgated, the overall efficiency under both models increased, but began to decline after 2008. This is similar to our expected results: before the unbundling, the continuous decline of efficiency accelerated the process of reforming; The overall efficiency of the reform has risen slightly, indicating that the reform has improved efficiency to a certain extent. this trend has changed since 2008, indicating that the effect of the reform has weakened and a new round of reform in power system is urgently needed.

Besides this, both SE and TE of southern China are higher than northern China, and the quality of services has a significant influence on the technical efficiency of the power grid companies.

Conclusions

Firstly, in 2002, the unbundling of the generation sector and power grid increased the degree of distinction between the grid companies, to a certain extent, which played a key role in promoting incentives.

Secondly, service efficiency and technical efficiency are significantly different, considering the quality of service dimensions affect the efficiency analysis results. The focus of future reform of power system should be on improving the efficiency of technology and services, and further improving the quality of electricity supply.

Thirdly, the reform in 2002 has played a certain role in promoting some southern power grid enterprises, but the efficiency of northern power grid enterprises has dropped. Which is opposite from what we expect in the first place.

References

[1] Tovar B, Ramos-Real F J, Almeida E F D. Firm size and productivity. Evidence from the electricity distribution industry in Brazil[J]. Energy Policy, 2011, 39(2):826-833.

[2] Galán J E, Pollitt M G. Inefficiency persistence and heterogeneity in Colombian electricity utilities[J]. Energy Economics, 2014, 46(1403):31-44.

[3] Filippini M, Wetzel H. The impact of ownership unbundling on cost efficiency: Empirical evidence from the New Zealand electricity distribution sector[J]. Energy Economics, 2014, 45:412-418.

[4] Anaya K L, Pollitt M G. Using stochastic frontier analysis to measure the impact of weather on the efficiency of electricity distribution businesses in developing economies[J]. European Journal of Operational Research, 2017, 263(3), 1078-1094.

[5] Cadena A, Marcucci A, Rez J F. Efficiency analysis in electricity transmission utilities[J]. Journal of Industrial & Management Optimization, 2017, 5(2):253-274.

[6] Jondrow J, Lovell C A K, Materov I S. On the estimation of technical inefficiency in the stochastic frontier production function model [J]. Journal of Econometrics, 1981, 19(2):233-238.

[7] Kumbhakar S C, Gudbrand B, Lien G. Technical efficiency in competing panel data models: A study of Norwegian grain farming[J]. Journal of Productivity Analysis, 2014, 41(2):321-37.

[8] Deng N Q, Liu L Q, Deng Y Z. Estimating the effects of restructuring on the technical and service-quality efficiency of electricity companies in China[J]. Utilities Policy, 2018, 50:91-100.

[9] Coelli, T. J., A. Gautier, S. Perelman, and R. Saplacan-Pop Estimating the Cost of Improving Quality in Electricity Distribution: A Parametric Distance Function Approach[J]. Energy Policy, 2013, 53, 287-297.