Productivity growth and deregulation of Japanese electricity distribution

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ABSTRACT

Deregulation of Japanese electric power industry began in 1995. After the amendment of Electricity Utility Industry Law in 1995, competition was partially introduced in a generation sector and retail competition started from 2000. Eligibility to choose suppliers was gradually extended from larger to smaller customers. As of 2008, almost all customers except households can choose their electricity suppliers. Based upon both previous implementation result of competition policy and review on their achievement, Japanese government will begin new policy debate in 2013 to assess further retail competition which includes household customers. To prepare for policy suggestion on the future electric power industry, this study examines the cost structure of Japanese electricity distribution. For the purpose, we estimate a multi-product translog cost function of Japanese electricity distribution from 1983 to 2003. Using the estimated cost function, we calculate several economic measures such as productivity growth, technical change and economies of scale and scope. The empirical results of this study indicate the improvement in productivity growth after deregulation.

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1. Introduction

Since the 1990s, many countries have deregulated the electricity industry and implemented its restructuring policy. Such a deregulation trend is observed in the United States, European countries and Asian countries.[1] In the deregulation process, some public utility entities were privatized and/or restructured. Exchange markets were often established for whole-sale power trades and competition was linked to a generation sector of electricity (e.g., Sueyoshi and Tadiparthi, 2007, 2008a, b). In addition, customers obtained eligibility to choose their retail suppliers from incumbent utilities and new entrants. Electricity deregulation started after other regulated industries such as airlines (e.g., Chan and Sueyoshi, 1991) and telecommunications (e.g., Sueyoshi, 1996). Those industries began deregulation from the 1970s and 1980s. However, a delay in the deregulation of the electricity industry does not imply that restructuring of the industry is not important. Rather, we expect the electricity restructuring may produce a larger economic impact than that of the other industries.

Japan cannot escape from the business trend. In Japan, there are ten vertically integrated investor-owned electric power companies which have been operating from generation to retail supply functions. Before deregulation, the companies consisted of regional monopoly. Consequently, competition did not exist among them. To change the industrial structure of electricity, Japanese government amended the Electric Utility Industry Law (EUIL) in 1995 for the first time during past 35 years. Along with the amendment, the Japanese government has gradually deregulated the electricity market. Independent Power Producers (IPPs) immediately entered into the generation market so that competition was partially introduced in the generation sector in such a manner that utility firms made competitive bidding to access additional generation capacities. The EUIL was subsequently amended in 1999 which resulted in partial retail competition since 2000. The retail market was gradually liberalized from larger customers to smaller ones. Since 2005, the eligibility has been lowered to 50 kW (kilowatts). Thus, almost all customers, with the exception of households, are eligible in choosing their suppliers from incumbent utilities and new entrants.

As of 2008, the essential part of the Japanese electricity industry still keeps vertical integration on generation, transmission, distribution and retail activities. After the deregulation, accounting unbundling is applied within the vertical structure of electric power utilities. The incentive regulation such as price-cap regulation, often found in some countries, is not assigned to Japanese electricity industry. Hence, the Japanese deregulation implies generation and retail services. The transmission and distribution are still under regulation, which are vertically integrated into incumbent electric power companies. However, under a competitive pressure from deregulated generation and

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[1] Sioshansi and Pfaffenberger (2006) have provided information on recent status and issues of electricity liberalization in many countries.

retail activities, Japanese electric power companies are now directing themselves toward the cost efficiency of their distribution in order to improve their productivity.

Considering the implementation result of past deregulation policy in Japan and the current status of electricity restructuring in the other nations, the Japanese government will initiate a policy debate from 2013 among policy makers, corporate leaders, and individuals who are interested in the policy issue on electricity. The main issue will be the expansion of eligibility to household customers. We are interested in the policy issue because the deregulation was introduced to improve the cost efficiency of the industry and thereby, to provide end users with lower electricity rates. Before the policy debate for further retail competition, it is important for us to examine the impact of deregulation on the electricity industry from a perspective of productivity growth and cost structure of the industry. In particular, we need to examine the distribution division because the impact of deregulation has not been fully investigated in terms of electricity distribution even though the distribution network is technically important for successfully operating the deregulated power market.

The purpose of this research is to measure the productivity growth of the distribution division of Japanese electric power companies and examine the impact of deregulation on the productivity. To attain the research objective, this study estimates a multi-product cost function of the distribution divisions in Japanese electric power companies, using a panel data set (1983–2003). This study also examines a technical change and economies of scale, which are components of productivity growth, and economies of scope between distribution services to regulated and deregulated customers.

The remainder of this study is organized as follows. Section 2 reviews previous studies concerning electricity deregulation. Section 3 describes economic concepts and estimation methods utilized in this study. Section 4 describes a multi-product translog cost function to approximate an unknown cost structure of Japanese electricity distribution sector. Section 5 describes a data set used in this study. Section 6 summarizes empirical results obtained from our investigation. This section also documents policy implications for Japanese electricity industry and its future deregulation. Section 7 concludes this study along with future research agendas.

2. Literature review

This study reviews previous studies on the estimation of cost functions for utility firms from the two perspectives: (a) economic concepts and influences of electricity deregulation and (b) methodological extensions for the cost function measurement. Then, the position of this study is discussed by comparing it with the other studies.

2.1. Economic concepts and influences of electricity deregulation

In an early stage, competition in the electricity generation was implicitly supported by Christensen and Greene (1976) who examined economies of scale in the generation sector of US electric power industry. Previous studies on the electricity transmission and distribution divisions supported a general view in which the electricity distribution was considered as a natural monopoly. The number of the studies on distribution and transmission was not as large as that of the generation sector of utility companies. Among them, Huettner and Landon (1977), Roberts (1986), Nelson and Primeaux (1988), Giles and Wyatt (1993) and Yatchew (2000) studied the economies of scale in the electricity distribution. Meanwhile, another group of research,

including Salvanes and Tjotta (1994), Burns and Weyman-Jones (1996), Kumbhakar and Hjalmarsson (1998), examined the operational efficiency of an electricity distribution sector. They used econometric methods to estimate production and cost functions. Most of their empirical results indicated that the distribution of electricity was characterized by economies of scale, although the degree of the economies depended on their data, periods and econometric models.

In the same research stream, Ramos-Real (2005) discussed electricity deregulation from a perspective of cost analysis, along with an extensive survey on previous studies which utilized the estimation of cost functions. His study concluded that transmission and distribution grids were a natural monopoly so that competition would produce an efficiency loss. In addition, a multi-product framework was recommended for the analysis on vertical integration of electricity. He discussed several problems in the electricity markets where the productivity growth of utility firms were not passed to the final customers in terms of reduction in electricity prices. Zarnikau and Whitworth (2006) supported the view, which indicated that, contrary to common expectations, household electricity costs in Texas increased at a greater rate than those of other states where retail competition was not introduced.

Besides the US deregulation experience, Filippini and Wild (2001) estimated a linear average-cost function, using data of Swiss electricity distribution utilities and discussed a use of the average-cost function for yardstick regulation on network access prices. Filippini et al. (2004) estimated a cost frontier function, using five Slovenian electricity distribution utilities, over the period from 1991 to 2000. They measured cost efficiency and scale economies, and suggested mergers of distribution utilities. Chang and Tay (2006) simulated possible efficiency gains from various deregulation scenarios of electricity in Singapore, using a linear programming model. They indicated that cost gains could be about 8% of the current production cost. Akkemik (2009) examined Turkish electricity generation by estimating a cost function. The estimation results indicated the existence of economies of scale and a technological progress in the Turkish electric power industry.

2.2. Methodological comparison in the measurement of cost functions

It is true that the conceptual development, discussed above, is important in investigating various empirical issues regarding the deregulation of the electric power industry. Similarly, previous studies explored methodological extensions for measuring cost functions because the measurement serves an empirical basis for investigating the existence of economic concepts related to the deregulation. Recent studies in the research group, which have estimated cost functions and cost frontier functions for distribution companies, include Farsi and Filippini (2004), Farsi et al. (2006), Farsi et al. (2008) as well as Farsi and Filippini (2009).

The recent studies can be summarized in the following manner: Farsi and Filippini (2004) estimated log-linear cost frontier functions using ordinary least squares (OLS), which was also applied to several panel data models for 59 distribution utilities from 1988 to 1996 in Switzerland. As panel data models, the study used random effects generalized least squares (GLS), random effects maximum likelihood estimation (MLE) and fixed effects model for estimation and compared results among them. Farsi et al. (2006) used the same data set and extended their comparative study of the panel data cost frontier models into estimating a true random effects model. Farsi and Filippini (2009) extended further the comparative study among panel data models