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From regulation to deregulation: an empirical study of Japanese electric utility R&D investment behavior under transition

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Abstract

The electricity deregulation started from the 1990s has altered the R&D behavior of electricity utilities remarkably. This paper investigates the impact of generation deregulation, retail deregulation, government R&D expenditure and firm size on electric utility R&D investment at the firm level. We try to estimate how incumbent electricity utilities change their R&D strategy to adapt to new challenges during the transition a competition environment. We show for 9 vertically-integrated, regional monopolized utilities in Japan over the period 1978-2014 that under the process the of deregulation and owing to the increasing competition pressure from generation sector and retailing sector, R&D expenditure dramatically declined. Larger utility spends more R&D than small utilities. Government energy sector R&D input is positively correlated with utility R&D expenditure. Also, the breakups of R&D expenditure from 1994 to 2005 imply that the R&D priorities of the electric companies switch to cost-saving and business-oriented projects under the deregulation process. The declining R&D efforts may be detrimental to the reliability and dynamic efficiency of the electricity system especially more renewable energy has been incorporated, as well as the innovation maintenance of introducing smart grid and environmental concerns.

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Keywords: electricity deregulation; R&D expenditure; electric utility; innovation.

Introduction

Over the last two decades, deregulation has been implemented in Japanese electric sector with the aim of stimulating competition, increasing efficiency and reducing electricity price following the great trend of worldwide deregulation. Adapted to the overall economic reform which aims at activating economic in

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Japan, together with gas deregulation scheduled in 2017, electric deregulation has been changing the electricity industry in Japan. Recently, residential electricity retailing in Japan was deregulated in April 2016. Gas companies, oil companies, and even telecommunication companies rushed into electricity retailing. Fierce competition and restructuring are expected to activate electric industry.

There is a large body of literature on evaluating the effectiveness of the electricity reform in Japan. Hattori and Tsutsui [1] explained the relationship of deregulation and electricity price using panel data of OECD. Kaino [2] evaluated the impacts of electricity reform and gas reform based on the firm-level financial statistics. He found that deregulation leads to a reduction in capital investment and labor expenditure of the electric companies which lead to a reduction in total cost and increasing efficiency. Nakano and Managi [3] and Tanaka et.al [4] also examined the efficiency of the electric companies using DEA approach with Luenberger indicator implying that deregulation brings in increasing in efficiency but may also lead to investment uncertainty and blackouts

Most previous studies focus on the benefit of static efficiency from the reform. However, some researchers raised the concern regarding the “unintended consequence” even at the beginning of the reform [5] that declining R&D expenditure after the deregulation [6-9]. Recently, more scholars argued that increase in static efficiency may at the expense of dynamic R&D by monitoring the activities of the companies related to electric industry under deregulation in US and EU using R&D expenditure and patent data [10-14]. It is widely recognized that deregulation will reduce R&D investment and innovation and these impacts will have profound implication for the future reliability of the electricity system. However, in Japan, this topic is scarcely investigated. To our best knowledge, only Hattori [15] reported an initial observation of the R&D activities of the electric sector. This paper intends to fill this gap to expand our understanding of Japanese electric sector R&D activities under the process of deregulation using data of 9 vertically-integrated, monopoly utilities in Japan over the period 1978-2014. Also, this work contributes to existing literature by including the market competition effect introduced by deregulation into empirical analysis.

The paper is organized as follows: In Sector 2, we build two models to estimate the overall impacts of deregulation on R&D expenditure of the electric utilities and the breakup of the impacts. Sector 3 is a description of our variable and data. Sector 4 is the results of our regression. Section5 concludes the paper and provides policy implication of this research.

Methodology

2.1 Basic model

We begin with the basic model by estimating the overall effect of deregulation on firm-level R&D expenditure following Eq. (1) with pooled OLS, fixed effect model, and random effect model.

$$\text{LnRD}_{i,t} = \alpha + \beta \text{DEREG}_{1995} + \sum_{r=1}^m \delta_r F_{i,t} + \sum_{k=1}^n \theta_k P_{i,t} + \varepsilon_{i,t} \quad (1)$$

The dependent variable is the nature logarithms of R&D expenditure where i denotes the firm and t denotes the year. α is constant. DEREG_{1995} is the deregulation dummy which implies the effect of deregulation. $F_{i,t}$ is the vector of firm character variables and $P_{i,t}$ stands for the vector of policy and macroeconomic variables.

Japanese electric utilities follow very similar organization structure, business pattern and ownership (regional monopolies, vertical integrated and private owned). Thus, firm character variable vector is

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