Available online at www.sciencedirect.com
SCIENCE DIRECT®
International Journal of Industrial Organization
22 (2004) 67–81
International Journal of Industrial Organization
www.elsevier.com/locate/econbase

Technological externalities and economies of vertical integration in the electric utility industry

Jiro Nemoto[a,*], Mika Goto[b]

[a] *Graduate School of Economics, Nagoya University, Nagoya 464-8601, Japan*
[b] *Socio-economic Research Center, Central Research Institute of Electric Power Industry, 1-6-1 Ohtemachi, Tokyo 100-8126, Japan*

Received 20 March 2002; received in revised form 16 April 2003; accepted 1 May 2003

Abstract

This paper investigates economies of vertical integration of the electric utility industry, focusing on the technological externality between the generation and transmission–distribution stages. For this purpose, a shadow cost function of the symmetric generalized McFadden form is estimated using panel data on the transmission–distribution stage of nine Japanese electric utility firms. The results show that there exist the technological externality effects of generation facilities on the cost of the transmission–distribution stage, suggesting economies of vertical integration.

JEL classification: D61; D62; L22; L94

Keywords: Economies of vertical integration; Shadow cost function; Allocative inefficiency; Electric utility industry

1. Introduction

In the last two decades, the policy view on public utilities has dramatically changed, favoring competition under the market mechanisms over regulation by the government. Those changes in views on the electric industry are based on the belief that the generation stage has exhausted scale economies, while the transmission and distribution stages maintain their natural monopolistic characters. Indeed, in the UK the divestiture of a

* Corresponding author. Tel.: +81-52-789-4929; fax: +81-52-789-4924.
E-mail address: nemoto@cc.nagoya-u.ac.jp (J. Nemoto).

0167-7187/$ - see front matter © 2003 Elsevier B.V. All rights reserved.
doi:10.1016/S0167-7187(03)00091-2

monopolistic supplier, the Central Electricity Generating Board, was executed by separating the generation stage from the vertically integrated production process and placing it in a competitive market environment. Several US states have also pursued vertical disintegration of incumbent utilities so as to introduce competition in the generation stage.

However, the electric industry is characterized by strong technological links among different stages of the production process. Even if electric generation is no longer a natural monopoly, vertical disintegration may cause a loss of cost efficiency. This paper aims to investigate economies of vertical integration, focusing on the technological externality between the generation and transmission–distribution stages.

To the best of our knowledge, there are two approaches for testing economies of vertical integration. One is a subadditivity test of the multioutput cost function in which an output of each stage is specified as one output of a vertically integrated firm. Following this approach, Kaserman and Mayo (1991) and Gilsdorf (1994) find evidence for the existence of economies of vertical integration. The other approach is to test separability among the production stages. If the generation stage is separable from the transmission–distribution stage, no benefit is gained by vertical integration because integrated and disintegrated processes are technologically equivalent. Lee (1995) tested the linear separability of the translog cost function and rejected separability hypotheses among generation, transmission and distribution stages. Hayashi et al. (1997) also provided supporting results for economies of vertical integration using a variant of the separability test.

Both approaches examine the cost function as a whole to judge whether a set of its parameters reflects any possibilities of cost savings due to vertical integration. They are, however, not explicit about the sources from which economies of integration arise. Although previous studies have generally agreed on the existence of some economies of vertical integration, it is still an open question to identify which aspects of the production process really cause such economies.

From an engineering viewpoint, the transmission–distribution facilities operate as a unified network together with the generating plants connected to them. A significant technological interdependency is thus most likely to be observed in the transmission–distribution stage in relation to the generation stage. This paper focuses on this point and examines whether the cost structure of transmission–distribution exhibits the effects of technological externality originating from the generation plants. If the generation plants cause such an externality in the transmission–distribution stage, centralized decision-making over the stages can produce economies of integration.

We estimate a cost function for transmission–distribution stage using panel data for nine Japanese electric utilities over the 1981–1998 period. Technological externality is examined by testing whether the generation plants act as a public input in the cost function. While our approach might be simple, it provides intuitively interpretable results and has direct implications for policy issues including vertical divestiture.

Unlike previous studies, we do not assume spontaneous adjustment of inputs to their optimal levels. The empirical literature on the electric industry has repeatedly claimed that departures from efficient firm behavior have been due to regulatory bias and fixity of the inputs. We employ a shadow cost function from which estimable demand equations for