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Productivity decomposition and economies of scale of Korean fossil-fuel power generation companies: 2001–2012

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ABSTRACT

This paper examines TFP (total factor productivity) growth and economies of scale of Korean fossil-fuel power GENCOs (generation companies) between 2001 and 2012. For this empirical investigation, a panel data econometric approach was employed with specification tests in order to obtain robust results. The findings indicate that an average growth rate of the TFP is 0.33 percent and that GENCOs enjoyed economies of scale for the study period. Based on these results, managerial and industrial implications are provided.

1. Introduction

Since the Chilean electricity reform in 1980, the world electricity industry has undergone serial reform [9]. The core of this reform was deregulation. The rationale of the deregulation was to lower electricity prices so that consumer surplus increases by making markets more competitive. Market competition was believed to increase by the break-up of the former vertically integrated electricity utilities and the separation among/within the generation, transmission and distribution. In line with this disintegration, wholesale and retail electricity markets were expected to play an important role in establishing competitive markets. Through the reform process, the productivity and efficiency of electricity companies had also been expected to increase [10].

Although the Korean electricity industry is not the exception of the global reform trend, its reform is particularly related with its economic condition. After the Korean War in 1950, Korea showed very rapid economic growth due to state-led economic planning for fostering manufacturing industries from the 1960s through the 1980s [28]. A stable supply of electricity was one of the main policy issues in order to provide sustenance for the growth of manufacturing industries. The economy, which had showed a rapid annual growth rate in GDP at 7.4 percent, suddenly collapsed during the 1997 Monetary Crisis. During this period, Koreas GDP decreased by 6.7 percent in 1998 and fixed investment contracted by almost 40 percent. In order to overcome this crisis, the Korean government adopted numerous approaches suggested by the International Monetary Fund. The remedies included various macro and micro-level policies with a focus on the government-owned and private sectors, and the financial and labor markets. Rich policy tools were introduced, e.g., the liberalization of foreign investment, the restructuring of conglomerates, the fostering of the IT industry, and layoffs [6]. The privatization of government-owned firms, where inefficiency and low competitiveness had prevailed, was also considered for the restoration of the Korean economys international credibility and as one of the solutions to the Crisis.

In order to propel privatization, the Korean government announced the Three Principles for Privatization. The principles were as follows: i) fast privatization or phased-in privatization accompanied by restructuring, ii) the review of the diversification of disposal and the adjustment of the disposal period in order to maximize salable values, and iii) the introduction of public offerings and employee ownership in order to expand greater public participation [23]. In July of 1997, in line with these principles, eleven government-owned firms were privatized. Among these government-owned firms were: KEPCO (Korea Electric Power Corporation: electricity generation, transmission, distribution, and

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retail), POSCO (Pohang Iron and Steel Company: iron and steel manufacturing), KT (Korea Telecom: telecommunication), and KOGAS (: supply of natural gas). For KEPCO, the Korean government applied a phase-in approach to its privatization.

The timeline for privatizing KEPCO was to take place over a period of ten years. With a successful separation between the generation and transmission/distribution functions, the generation function was to be privatized at the earliest possible time. In 1998, five percent of the governmental share was sold to the public and deregulation was introduced to reform the electric sector. The generation facilities were to be sold in 1999. Several subsidiaries of KEPCO were also privatized between 1999 and 2001.

In 2001, the generation function of KEPCO was totally separated and six generation subsidiaries were established, i.e., five fossil-fuel power generation companies (Dongseo, Jungbu, Nambu, Namdong, and Seobu) and a hydro and nuclear power generation company (Korea Hydro & Nuclear Power Co., LTD). Although the sale of Namdong was publicly announced in 2002, the government failed to look for a suitable buyer [26]. When this article was being written, all six of the GENCO (generation companies) were producing electricity and selling it to KEPCO vis–vis the KPX (Korea Power Exchange). Note that after 2001, KEPCO did not have generation function but only transmission and distribution functions.[1]

Since 2002, the government has halted the reform of electricity industry in response to public opinion. Because of this standstill, the direction of future reform has been the subject of considerable debate among scholars, practitioners, and policy makers. One of main issues being debate is regarding the operation of the GENCOs, including ownership restructuring and the optimal size of operations. The reason for this debate is that because while the total share of five of the fossil power GENCOs belongs to KEPCO, it has been denied a voice regarding the operation of the GENCOs.[2]

The present paper raises a question regarding the operation of the Korean GENCOs and attempts to find the optimal size of their operations by focusing on the GENCOs economies of scale. Although the main strand of research on economies of scale has been conducted using cost functional approaches to investigate the GENCOs economies of scale, this paper uses a production functional approach since the estimation of cost shares is likely to be biased which consequently yields biased results on economies of scale. In estimating the GENCOs economies of scale, we used the theoretical exposition that IRS (increasing returns-to-scale) is a sufficient condition to economies of scale [4].

Most previous studies employ the dual approach, which employs the cost function in estimating productivity growth and its decomposed factors. The rationale of these studies is that GENCOs attempt to lower total cost when output production is *exogenously* determined. However, the rationale for the choice of the primal approach is that (i) the cost functional approach is likely to ignore the price volatility of electricity and not to capture quality changes in inputs, and (ii) the quality of output, i.e. electricity, remains unchanged [22]. Especially when the electricity demand outpaces the economic growth, the primal approach is suitable for investigating productivity growth and economies of scale of GENCOs. For the study period, the electricity demand increased dramatically with an annual increasing rate of 5.28%, outpacing the GDP increase (4.15%).[3] Hence, we believe that the primal approach is more suitable than the dual approach.

As aforementioned, cost functional approaches are the main strands for estimating economies of scale in the electricity industry. Ref. [7] investigated economies of scale in U.S. electric power generation between 1955 and 1970, and found that economies of scale had sacrificed during the study period. Ref. [15] found the existence of economies of scale among U.S. coal-fired steam electric generating plants between 1965 and 1975. Ref. [31] examined economies of scale in regulated private steam-electric utilities in the eastern and north–central regions of the U.S. in 1987 and found the existence of economies of scale in that sector. Ref. [5] estimated a tanslog variable-cost function of the Kuwait electricity generation sector using time-series data between 1965 and 1990, and found diseconomies of scale in the generation of electricity. Ref. [18] estimated a multi-product translog cost function of the Japanese electricity distribution sector between 1983 and 2003, and found that i) economies of scale positively affected TFP (total factor productivity) growth, and ii) its magnitude gradually decreased over the study period. Ref. [1] used the cost functional approach to investigate economies of scale of the Spanish electrical utility industry during the period between 1987 and 1997 and found that the Spanish electrical utility industry was not characterized by economies of scale. Ref. [13] examined economies of scale of Swiss small and middle-sized electricity companies between 1997 and 2005 and found the existence of economies of scale across a major part of their sample.

Distance functions are also employed when investigating economies of scale of electric generation. Ref. [2] used a distance functional approach to investigate economies of scale of Spanish electric firms between 1989 and 1997 and found that some of the electric utilities showed economies of scale. Ref. [19] examined the technical efficiency and returns-to-scale of U.S. electric power utilities between 1992 and 2000 and found that increasing returns-to-scale prevailed in the generation sector during the study period. Ref. [24] utilized various cost functional forms to investigate economies of scale of the Finnish electricity distribution utilities between 1997 and 2002 and found the existence of economies of scale for all of the model specifications and estimation methods.

Ref. [22] used the production functional approach for investigating economies of scale of the electric sector. They investigated economies of scale of the U.S. electric power companies between 1957 and 1987 at five-year intervals and found that increasing returns-to-scale prevailed for that period. This result, in turn, signified the existence of economies of scale for the sample.

As aforementioned, in order to find the optimal size of Korean GENCOs, this paper attempts to estimate their returns-to-scale between 2001 and 2012. The estimation results yielded i) a significant growth rate in TFP and ii) a prevalence of economies of scale. Based on these empirical results, relevant policy implications are provided. The main contribution of this paper is to investigate the current status of Korean GENCOs from the perspective of economics, especially focusing on the economies of scale and technical change by composing productivity growth. We would like to emphasize that the present study is thought to have novelty that it analyzes the optimal scale size and propose policy implications regarding restructuring. The finding of this optimal size using the primal approach is the first attempt for the Korean GENCOs. It needs to be emphasized that the similar size of the GENCOs was also found in Ref. [29]; whilst it employs the *dual* approach.[4] Ref. [21] evaluates the impact of load factor, facility and generator types of Korean GENCO plant using a SPSC (semiparametric smooth

[1] KEPCO has a negligible share of generation, which mainly comes from hydro generation. As of 2013, its share to national generation is only 7.4e-06 percent.

[2] Only the Ministry of Strategy and Finance holds the floor regarding the GENCOs operations.

[3] We calculated theses rate by the indicators listed in Statistics Korea.

[4] The primal approach uses a production function in estimating productivity growth and its decomposed factors, while the dual uses a cost function for the same purpose.