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Electricity restructuring, greenhouse gas emissions efficiency and employment reallocation

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HIGHLIGHTS

- GHG emissions efficiency and employment reallocation have a feedback effect.
- GHG emissions efficiency improvement increases the employment shares of the related industries except mining.
- Employment share increases in those industries have negative effects on emissions efficiency.
- Electricity restructuring increases overall employment except farming.

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ABSTRACT

This paper focuses on demonstrating the feedback relationships between greenhouse gas emissions efficiency in the electricity sector and employment reallocation with a consideration of the effects of electricity restructuring and socio-demographic factors. We postulate the construction, information, manufacturing, utilities, and mining sectors as a group of emissions efficiency-related industries and identify the mutual relationships. The emissions efficiency positively influences the job shares of these industries except mining, whereas increased employment in these industries has a negative effect on the emissions efficiency. Electricity restructuring has a positive effect on overall employment, however, it does not have a statistically significant effect on the emissions efficiency. Additionally, population aging and educational attainment have positive effects on the emissions efficiency, and a higher proportion of rental households has a negative influence on it. Increases in renewable energy and nuclear energy generation have elastic effects on enhancing emissions efficiency.

1. Introduction

This study assesses a feedback effect between greenhouse gas emissions efficiency (GHG-EE) in the electricity sector and employment reallocation (ER) in the U.S. with a consideration of effects of electricity restructuring and socio-demographic factors. The electricity market comprises the four main areas of generation, transmission, distribution, and retail market. Since the 1990s, a competitive environment has initiated regarding generation and the retail market. However, the transmission and distribution markets have remained under regulation for the stable operation of the electrical power systems. The effects of electricity market deregulation have been thoroughly examined because the electrical power system is a major infrastructure sustaining economic activities.

Although the 2000 California electricity crisis led to a suspension of restructuring schemes in seven other states, 15 states continued to deregulate their wholesale markets and consumers' retail options.[1] The main purpose of electricity restructuring is an improvement of operational efficiencies because the naturally integrated system has yielded side effects and inefficient management (Joskow, 1997). In other words, price reductions are expected to result from the competitive environment, since electricity itself is a homogeneous product. Also, more efficient firms will enter the

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[1] Arizona, Arkansas, California, Montana, Nevada, New Mexico, and Virginia suspended deregulation; Delaware, District of Columbia, Illinois, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, and Texas continued their restructuring policies.

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electricity market and incumbents put more efforts to retain their competitiveness after the deregulation. As electricity has played a more important part in recent lifestyle, structural changes in the electricity sector could affect the overall economy.

In addition, the United Nations Framework Convention on Climate Change was forged in 1992 to stabilize GHG emissions and the Kyoto Protocol was established in 1997 to oblige the abatement of the emissions to a specific level in each regulated country. Despite several controversies about the historical responsibilities of developed and developing countries, environmental regulations and policies pertaining to GHG emissions or the applications of renewable energy sources have increased globally. Although the U. S. has not formally participated in any global mandatory controls related to environmental issues, gradual implementations of environmental legislations have proceeded, such as Renewable Portfolio Standards (RPS). From this perspective, restructuring the electricity sector, which accounts for about 40 percent of national energy consumption (US Energy Information Administration, 2015), could also affect GHG-EE through several channels of the demand and supply sides.

Furthermore, electricity restructuring and GHG-EE could matter to employment. Recent efficiency gains from technology progress may destroy jobs, because automation and mechanization have replaced workers. As the information age has progressed, job destruction can be severe because small numbers of workers can be hugely productive in the growing service sector. Nevertheless, the overall patterns of job destruction and job creation depend on the cost of renovation, and vary across sectors (Mortensen and Pissarides, 1998) and categories of work (Autor, 2015).

Improvements in GHG-EE can positively influence job creation not only in the electricity sector but also in the related industries. This is because the process of the improvements in the electricity sector is highly labor-intensive (Rifkin, 2014). In the generation area, there is a need to install additional equipment or facilities in existing thermoelectric power plants, for instance, integrated gasification combined cycle (IGCC) power system or carbon capture and storage (CCS). Also, there should be an expansion of power plants for renewable energy sources, such as solar, wind and nuclear, instead of the traditional ones (Sims et al., 2003). The transmission and distribution system would be replaced to secure a capacity for distributed generation and information-based management system, so called smart grid. Finally, in the retail area, an installation of new information and communication technology devices would be achieved for real-time measurement and collection of data on electricity use and the emissions, such as smart metering (Gungor et al., 2011). Also, newly growing electric products, such as plug-in hybrid electric vehicle, would be important factors to GHG-EE in the electricity retail market (Hu et al., 2015). Since these replacements and developments are expected to gradually progress over the short and mid-term (Rifkin, 2014), GHG-EE development could generate numerous jobs in electricity and related-sectors in this period. This study postulates construction, information, manufacturing, utilities, and mining as the related industries, and figures out the effects of GHG-EE in the electricity sector on employment in these industries as well as overall employment.

Numerous studies consider the influences of electricity restructuring on GHG emissions (such as CO_2) and job creation. However, these studies limit their focus only to description of possible scenarios and outcomes without empirical analysis. In addition, employment, which relates to the economic activities of these industries, could simultaneously have significant influences on GHG-EE. However, there are few studies dealing with this possible feedback effect between GHG-EE and employment reallocation.

In addition, this study includes the effects of socio-demographic changes on the GHG-EE. Not only in developed countries, but also in many of developing countries, the proportion of the elderly shows a steep increase. In 2015, most of developed countries, such as U.S., Russia, and U.K, show 20–24 percent as the proportion of population aged 60 or over, and some European countries, such as France, Germany, and Italy, show 25–29 percent. Most of developing countries, such as China and Republic of Korea, show 10–19 percent of the proportion. In 2050, however, most of countries, except some countries of Africa, and South and Central Asia, will become super-aging society (UNDESA Population division, 2015). Since the dramatic changes of demographic structure affect a sustainability of national economic system and policies, many economic literature have diagnosed the possible negative effects of the aging society on the economy (Cutler et al., 1990; Gruber and Wise, 2001). In this respect, some papers deal with immigration as a practical solution to retain working-age population and economic growth (Blank, 2016). Among socio-demographic changes, this study focuses on population aging, and increasing educational attainment, rental households and one-person households, related to electricity consumption.

In this study, we aim to identify a feedback relationship between GHG-EE and ER by constructing a simultaneous equation system. Also, we examine the determinants of the implementation of electricity restructuring, which affects both GHG-EE and ER, to apply to the identification of the mutual relationship. To this end, socio-demographic, economic, and electricity-related variables are considered. This study is presented as follows. Section 2 provides a brief overview of relevant literature. Section 3 describes the data used in the analysis and the estimation model. Section 4 presents the empirical results and Section 5 discusses the conclusions and policy implications from the results.

2. Literature review

Since electricity services and power systems are significant parts of social overhead capital, stable operation is the first priority for a sustainable economy. Hence, the power systems were initially owned by the central government, and thus electricity markets had natural monopoly properties under an integrated system. Under the Federal Public Utility Regulatory Policies Act of 1978 and Energy Policy Act of 1992, Qualifying Facilities and Independent Power Producers (as defined under those laws) could act as new entrants in the electricity market. Furthermore, between 1990 and 2000, 16 states ultimately opened their wholesale markets and retail options to consumers. Due to the importance of electrical services (described above), many studies have investigated the influences of electricity restructuring on the US economy in the years around 2000.

Nevertheless, there are few studies which empirically deal with the effects of socio-demographic factors on deregulation of electricity market. As for energy efficiency, however, Zarnikau (2003) and Bollino (2009) show that the higher income and education attainment, the higher willingness to pay (WTP) for energy efficiency. Also, age has a negative impact on the WTP for the efficiency (Zarnikau, 2003) and homeowners present the higher mean of WTP than rental households (Bollino, 2009).[2] In addition, as the main purpose of restructuring is a reduction of electricity price through operational efficiency improvement under competition, high electricity price and inputs prices, such as natural gas price, can be an important impetus for deregulation (Fagan, 2006).

[2] Zarnikau (2003) also acknowledged that homeowners will be positive to energy efficiency improvement, which contradicts to estimation results in the paper.