Energy 163 (2018) 258–269

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

The efficiency of electricity-use of China and its influencing factors

Yongxiu He [a, b], Fengtao Guang [a, b, *], Meiyan Wang [a, b]

[a] School of Economics and Management, North China Electric Power University, Changping, Beijing, 102206, China
[b] Beijing Key Laboratory of New Energy and Low-Carbon Development (North China Electric Power University), Changping, Beijing, 102206, China

ARTICLE INFO

Article history:
Received 2 June 2018
Received in revised form
20 July 2018
Accepted 17 August 2018

Keywords:
The efficiency of electricity-use
Epsilon-based measure
Kernel density estimation
Moran's I
Penalized panel quantile regression

ABSTRACT

The consumption of electricity accounts for a higher and higher proportion of the terminal energy structure. The efficiency of electricity-use thus should be of great concern, especially under the background of energy saving and emission reduction. Instead of measuring the efficiency of electricity-use via electricity intensity, the input-oriented epsilon-based measure (EBM) model under variable returns to scale, supported by a total-factor framework, is employed to evaluate the efficiency of electricity-use of China's 30 regions spanning from 2006 to 2015. Then kernel density estimation and Moran's I index are used to depict its dynamic evolution characteristics and spatial agglomeration characteristics. Finally, a penalized panel quantile regression model with fixed effects, taking unobserved individual heterogeneity and distributional heterogeneity into account, is applied to estimate the effects of probable determinants on the efficiency of electricity-use. It found that there are significant differences in the efficiency of electricity-use in terms of time and space dimensions, whose distribution seems to be a projection of the level of regional economic development. The regional efficiency of electricity-use exhibits a descending trend and is positively spatially autocorrelated. The impacts of various factors, namely, income level, population size, industrial structure, urbanization and FDI intensity, are obvious heterogeneous throughout the distribution.

© 2018 Elsevier Ltd. All rights reserved.

1. Introduction

Since launching its power system reformation in later 1980s, China has experienced an enormous growth of electricity consumption, which increased from 300.63 billion kWh in 1980–5919.80 billion kWh in 2015, with the average growth rate of approximately 9.71% per year [1]. Owing to its characteristics of cleanliness and convenience, electricity energy has become the most favorable and preferable way of energy consumption in modern social production and living. For China, with its present stable economic conditions, it has had demand-driven electricity consumption, rather than supply-driven. Thus due to the rising economic growth and development and the untiring pursuit of a reasonable quality of life, the increasing trend in electricity consumption is expected to continue in the foreseeable future. As the 13th National Five-Year Plan (2016–2020) released by Chinese National Development and Reform Commission (NDRC) anticipates, electricity consumption of the whole society will reach to 6800–7200 billion kWh in 2020, corresponding to the annual growth rate of 3.6%–4.8% on average, and electricity energy will account for 27% of the end-use energy consumption, with an increase of 1.2% relative to 2015.

Along with this increasing demand for electricity energy, the efficiency of electricity-use should be of great concern, particularly in the present "new-normal" phase of China's economy. In this context, the development of the economy emphasizes the importance of achieving dematerialization, that is, reducing the dependency on energy resources gradually, not simply the growth of gross domestic product (GDP) and the expansion of economic scale. In view of this, the efficiency of electricity-use should be one of the critical parameters considered for the formulation of energy-economics polices with the aim of reducing consumer demand for electricity energy while sustaining or even promoting economic growth. For example, on December 29th, 2016, the NDRC issued the "Energy Production and Consumption Revolutionary Strategy (2016–2030)", which pointed out that creating the new prospect of economical and high-efficiency energy utilization is an important and urgent task that must be completed. Nowadays a diverse set of programs, such as the construction of Global Energy Interconnection and the power transmission from west to east, are being

* Corresponding author. School of Economics and Management, North China Electric Power University, Changping, Beijing, 102206, China.
E-mail address: Guangft@126.com (F. Guang).

https://doi.org/10.1016/j.energy.2018.08.126
0360-5442/© 2018 Elsevier Ltd. All rights reserved.

positively implemented to establish a secure and sufficient electricity energy supply. However, the efficiency of electricity-use needs to be improved simultaneously so that redundant electricity energy consumption can be eliminated. In addition, although building more new power plants and technology and material improvement can relax increasing electricity demand requirement, it is undeniable that the potential significant costs resulted from new power plants and innovations would be a major issue facing the country. However, the more efficient electricity-use can serve as an alternative or complement to the abovementioned solution to address the growing electricity demand.

Electricity intensity, which is defined as the electricity energy input divided by the economic output, is a well-known indicator that commonly used as the metric of the efficiency of electricity-use (i.e. [2–4]). The greater the value of electricity intensity is, the more inefficient electricity-use is. According to this kind of indicator, China's electricity-use efficiency remains at a relatively lower level when compared with developed countries in the world. For instance, if China's electricity consumed per unit of GDP (measured in 2010 US$ prices) is taken as 1 in 2015, then that of the United Kingdom is 2.29, that of Germany is 2.43, that of France is 2.78, and that of the United States is 2.99 [5,6]. However, the assessment results may be a misleading estimate since electricity intensity is a partial-factor index neglecting the substitution effect of other key inputs such as labor force and capital stock on electricity energy. That is, electricity energy needs to be put together with other production factors in the actual production. For this reason, a total-factor framework is adopted to evaluate the efficiency of electricity-use in this paper.

In discussing performance assessment of energy utilization, a research gap in knowledge that needs to be specified is that existing energy-economics literature mainly concentrates on the aggregate energy-use efficiency from the perspective of total-factor framework, while total-factor efficiency of electricity-use has received little attention. In other words, the method of determining electricity-use efficiency is usually done under the framework of aggregate energy-use efficiency. Here, we define the total-factor efficiency of electricity-use as the ratio of target electrical energy input to real electrical energy input in a multi-input and multi-output economic system, which aims to minimum the input under the constant output or maximize the output under the fixed input. Then to make expression simplicity, the efficiency of electricity-use always refers to the total-factor efficiency of electricity-use unless noted otherwise in this study. Allowing for the increasing proportion of electricity energy in terminal energy consumption structure, the efficiency of electricity-use should also be considered and evaluated exclusively. Therefore, an empirical study focusing on the efficiency of electricity-use across Chinese provincial administrative regions from 2006 to 2015 with the total-factor framework will be conducted.

Moreover, the efficiency of electricity-use may evolve over time and can be heterogeneous across regions as a consequence of different development levels and uneven distribution of electricity resources in different regions. Then we also examine its regional differences over space and over time. Additionally, with power trading increasingly frequent and thorough among different regions, their electricity economics connections become more closely. Coupled with impacts of some social factors such as the spillover of technology and the flow of talent, the efficiency of electricity-use may display the spatial agglomeration characteristics, which is demonstrated by the Moran's I index in this paper.

After measuring the efficiency of electricity-use, a question then naturally arises of what factors have impacts on the efficiency of electricity-use and how they do. Through a quantile regression analysis of the efficiency of electricity-use on its relevant influencing factors throughout the conditional distribution, especially in the regions with the highest and lowest efficiency of electricity-use, the extent to which these factors influence the efficiency of electricity-use is revealed, and then how to achieve the targets for electricity-use efficiency enhancement is studied. This makes sense to provide insightful views for policymakers on drafting energy conservation and emission abatement policies.

The remainder of the paper is organized by the following structure. Section 2 briefly reviews the related literature. Section 3 introduces the methodology. Section 4 details the data and sources. Section 5 reports and discusses the empirical results. Finally, Section 6 presents the conclusions and policy implications.

2. Literature review

Despite considerable efforts made to investigate the energy efficiency at the national or regional levels, limited research on the efficiency of electricity-use has been conducted in this area. Existing literature usually regards electricity intensity as the proxy of the efficiency of electricity-use. While it is well understood that electricity intensity is not the same as the efficiency of electricity-use, this has not stopped electricity intensity indicator from being used as a metric of success or failure [7]. But in this study, we attempt to measure the efficiency of electricity-use from the perspective of total-factor, then its results may corroborate with that of electricity intensity. It should be noted that our focus is entirely on the consumption efficiency of electricity at the consumer side, not the supply side.

The concept of total-factor energy efficiency was first put forward by Hu and Wang [8], who defined it as the ratio of target energy input to real energy input. Since then, this concept has been extensively accepted and applied when investigating energy efficiency. Established as a non-parametric method, data envelopment analysis (DEA) has been widely utilized in the evaluation of total-factor energy efficiency. For example, Qin et al. [9] developed a novel DEA model which combines a virtual frontier and the global based bounded adjusted measure and evaluated the unified energy efficiency of China's coastal areas during the period 2000–2014. Based on four DEA models, Özkara and Atak [10] assessed the energy efficiency of the manufacturing sector across 26 regions in Turkey from 2003 to 2012. Similarly, Wang et al. [11] used the DEA model to measure the energy efficiency of China's industrial industry between 2005 and 2009 and investigated its efficiency development probabilities. Besides DEA, stochastic frontier analysis (SFA) is also a method of choice for total-factor energy efficiency evaluation. For instance, by using a balanced US panel data covering the period 1995–2007, Filippini and Hunt [12] employed this method to examine energy efficiency for 48 states based on an econometric energy demand model. In SFA, the specific from of production function needs to be assumed firstly [13]. Since having subjectivity, this assumption is not so reasonable in some cases. If follows, there may be bias and error on the assessment of energy efficiency. Therefore, we perform the DEA model in the measurement of the efficiency of electricity-use supported by a total-factor framework.

When modeling the efficiency of electricity-use, the undesirable outputs of electricity-use also need to be incorporated into the DEA model since they are produced along with the desirable outputs. Holding the largest carbon emissions in the world, China is confronting increasingly international pressure of emissions reduction [14]. Given this situation, carbon emissions are treated as the undesirable output in this study. In DEA, two main ways are usually adopted to address the undesirable outputs. One is the radial models represented by models of constant returns to scale model

Download English Version:

https://daneshyari.com/en/article/8948737

Download Persian Version:

https://daneshyari.com/article/8948737

Daneshyari.com